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# ***The* SCIENCE COUNSELOR**

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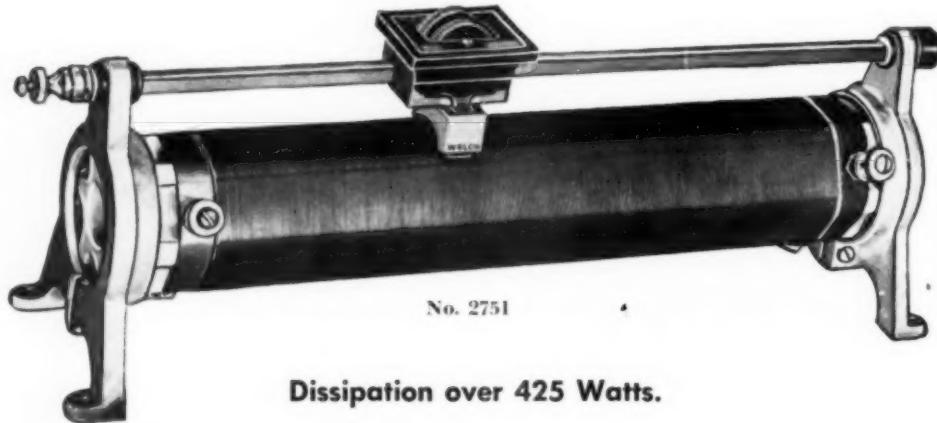
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Among the articles planned for publication in the near future are:

### Radioisotopes in Biology

By R. H. Burris, Department of Biochemistry, University of Wisconsin, Madison, Wisconsin.

### Chemical Weed Control

By A. L. Bakke, Research Professor, Bureau of Plant Industry, U. S. Department of Agriculture, Iowa State College, Ames, Iowa.

### Lecture Techniques

By Hubert N. Alyea, Department of Chemistry, Princeton University, Princeton, New Jersey.

### Guiding Science Students

By T. H. Dunkelberger, Department of Chemistry, Duquesne University, Pittsburgh, Pennsylvania.

### Fiction and Fact in Criminalistics

By Charles E. O'Hara, Co-author "An Introduction to Criminalistics" by O'Hara and Osterburg, New York City.

### Germ-Free Life

By James A. Reniers, Research Professor of Bacteriology, University of Notre Dame, Notre Dame, Indiana.

### Oysters in the Shell as Living Laboratory Animals

By G. Francis Beaven, Research Biologist, Department of Research and Education, State of Maryland, Solomons Island, Maryland.

### Fertilizers for the Garden

By Joseph B. Edmond, Department of Horticulture, Mississippi State College, State College, Mississippi.

### New Meanings in Insect Coloration

By William Hovanitz, Department of Biology, University of San Francisco, San Francisco, California.

# Saint Patrick's Shamrock

• By **Harold N. Moldenke, Ph.D.**, (Columbia University)

CURATOR AND ADMINISTRATOR OF THE HERBARIUM, NEW YORK BOTANICAL GARDEN, AND

**Alma L. Moldenke**

DEPARTMENT OF BIOLOGY, EVANDER CHILDS HIGH SCHOOL, NEW YORK CITY

*On St. Patrick's day you will have many opportunities to buy "shamrocks." But will they be the true shamrock?*

*It may astonish you to learn that no one has yet proved beyond a doubt what plant is the true shamrock used by St. Patrick in his famous illustration of the Trinity.*

*Here is a careful library and on-the-spot study of the problem, considered in the light of botanical science, folk lore, and history. We know it will interest you.*

Last summer we had an opportunity to spend a few days traveling through Eire. As we were setting foot on its soil, we recalled our earlier efforts to identify the "shamrock" plant so intricately worked into the folklore and history of this country. On the grounds surrounding the airfield at Shannon we walked over thousands of the most likely candidate, and over hundreds of the second and third most likely candidates—*Trifolium dubium*, the small yellow hop clover, *Trifolium repens*, the white or Dutch clover, *Trifolium pratense*, the red or honeysuckle clover. Only the vendors of various potted plants in Irish-American neighborhoods on or about March 17th are absolutely sure of the identity of the "true shamrock"!

*How can the science of linguistics help solve the riddle?* The Oxford<sup>3</sup> and Webster<sup>4</sup> dictionaries show that "shamrock" is derived from the Gaelic *seamrag* and the Irish *seamrog* or its diminutive *seamar*, which mean "trefoil, clover, honeysuckle." Some writers state that this Gaelic term signifies "three-leaved" and it was therefore applied originally to any plant with compound leaves of three leaflets. Through the centuries these words have been changed further to shamrote, shamrocke, sham-roke, shum-roke, shamroot, schramrock, shamrook, shamocke, shamrogh, shamrogh, shamerag, shamrug, shamrogue, chamroch, shammock, shamroque, shamrogge, shambrogue, shambrogh, shamrog, shamroge, to still other forms, and ultimately to our present-day SHAMROCK.

*How can folklore and history help solve the riddle?* Soon after landing in Ireland in the year 432 either from another part of the British Isles or from France, Saint Patrick established a mission in County Meath. While delivering a sermon to the inquisitive Druid natives on the hillside of Tara, he picked a leaf of three leaflets from some plant in the green sod at his feet and with it proceeded to illustrate the doctrine of the Holy Trinity so effectively that the audience was converted to Christianity then and there. This plant

was the "true shamrock," and this occasion was the reason why this plant was chosen as the national emblem of Ireland.

There is an old English belief—unsubstantiated—that the "shamrock" identifies Saint Patrick as the sham rock in contradistinction to Saint Peter who is the true rock upon which the Church is founded<sup>5</sup>.

As late as the 17th century Irish peasants were eating "shamrocks" as food. Campion<sup>6</sup> writes "Shamrotes . . . they feede upon." Holland<sup>7</sup> writes "They feed willingly upon mushrooms, shamroots . . ." Wither<sup>8</sup> writes "And feed on Shamrootes as the Irish doe." Piers<sup>9</sup> writes "Butter, new cheese, and curds and shamrocks, are the food of the meane sort all this season." Here are just a few snatches from the many references to this plant as a food source. Some mention "shamrocks" in addition to watercress; others mention "sham-

THE SAINT PATRICK OF ANCIENT AGES. A portrait of the Patron Saint of Ireland holding a shamrock leaf, from a woodcut in "The Most Ancient Lives of St. Patrick" by Rev. James O'Leary, D.D., sixth edition, 1882, lent by courtesy of the library of Notre Dame University.



rocks" as a kind of watercress. The latter grouping makes *Nasturtium officinale* a contender for the title of "shamrock," but since its leaf is not trifoliate, and since it does not ordinarily grow on naturally drained and open hillsides, it can be safely dismissed as a misidentification of these few earlier writers<sup>10, 11, 12, 13</sup>. Gerarde<sup>14</sup> in his famous herbal of 1597 definitely identifies this edible "shamrock" as *Trifolium pratense*.

From the 18th century on there is very little reference to the shamrock as food, since the more satisfying white potato from Peru was by then so well established in cultivation that it became known as the "Irish potato." The literature references are now to its emblematic use<sup>15</sup>. As a heraldic badge it marks the Kingdom of Ireland and also Saint Patrick, who is usually shown in the robes and mitre of a bishop whose upraised hand clasps a generalized trefoil, most often a stylized oxalis leaf. In the symbolic "language of flowers" the "shamrock," identifiable usually as *Trifolium repens*, indicates lightheartedness and loyalty. Showing how the Hibernians used this plant as a badge of honor, Johnston<sup>16</sup> writes in 1781, "he marked our hero on the left breast with a shamroque." The great Sir Thomas Moore<sup>17</sup> in 1813 described the plant as "Chosen leaf of Bard and Chief, Old Erin's native Shamrock!"

There has been much argument as to the identity of this "shamrock" that has been used as a badge or emblem. The watercress does not enter into these debates independently, but because it is mentioned earlier in the literature in reference to food. But several clovers, the wood sorrel and a few other trifoliate plants are contenders. The clovers suggested are: 1. hop clover (*Trifolium dubium*), 2. white clover (*Trifolium repens*), 3. red clover (*Trifolium pratense*), and 4. lesser yellow hop clover (*Trifolium minus*, which is often regarded as a variety of *Trifolium procumbens*).

The sorrel<sup>18</sup> suggested is the wood sorrel (*Oxalis acetosella*) which must be discounted because it is a plant of the dark moist woodlands, and not of exposed sunny hillsides like the famed one from which Saint Patrick gave his sermon. The other trifoliate-leaved plants suggested are: 1. black medic (*Medicago lupulina*) which has a good claim for the "shamrock" title not only because of the shape of its leaf but also because of its natural habitat, and 2. bird's foot trefoil (*Lotus corniculatus*) which is not usually associated with such growing conditions.

*How can botany help solve the riddle?* In their floral lists well-known botanical authorities show their lack of agreement as to the identity of the "true shamrock" even after careful study in the field, in the herbarium and in the library. Britten and Holland<sup>19</sup>, Britton and Brown<sup>20</sup>, Blanchan<sup>21</sup>, Henkel<sup>22</sup>, Lyons<sup>23</sup>, Sudell<sup>24</sup>, Webel<sup>25</sup> and Griffith<sup>26</sup> name it *Oxalis acetosella*. Standardized Plant Names<sup>27</sup> and Britten and Holland list it as *Trifolium minus*. Britten and Holland apply it also to *Trifolium pratense* which may not be adaptable or hardy enough to have been available at Saint Patrick's feet. This red clover is prominent and really successful in lush meadows. It is usually choked out of existence in competition with sturdier weeds on



**OXALIS.** Species of Oxalis and its close relatives often appear in representations of the Irish shamrock, and often they are grown in small flower-pots to be sold on St. Patrick's day. The species above, with characteristic trifoliate leaves, each leaflet slightly indented at the tip, making it somewhat chordate in outline, is Oxalis (or Caudoxalis) Bowiciana, photographed in the Thompson Memorial Rock Garden, New York Botanical Garden.

open hillsides. Britton and Brown, Mackay<sup>28</sup>, Stewart and Corry<sup>29</sup>, and Webel use *Trifolium repens* which may not even be a native of the Emerald Isle, but rather an immigrant of later date than the good Saint himself. Britton and Brown, Brenchley<sup>30</sup>, Lyons and Stuhr<sup>31</sup> list *Medicago lupulina*. Britton and Brown, and Jepson<sup>32</sup> and Robbins<sup>33</sup> identify it as *Trifolium dubium* (*Chrysaspis dubia*). In this instance Britton and Brown are concerned with the "true shamrock."

A member of the Royal Irish Society, Nathaniel Colgan, back in 1891 issued an appeal for specimens of "true shamrock" to be gathered throughout all of Ireland. There were sent to him from 21 of the 32 counties 49 specimens which proved to be the following: *Trifolium repens*, 24, *Trifolium dubium*, 21, *Trifolium pratense*, 2, and *Medicago lupulina*, 2.

When we recall the beautiful scenes that greeted our eyes and feasted our souls last summer, we want to

"Sing a song of Ireland,  
Blue lakes and sparkling rills,  
Gray rocks and misty moorlands,—  
Of shamrocks and green hills."

and to visualize these plants as *Trifolium dubium* or *Trifolium repens*<sup>34, 35</sup>. ●

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(Continued on Page 35)

# How Many Mesons?

• By Sister Mary Helene, C.H.M., M.S., (St. Louis University)

MARYCREST COLLEGE, DAVENPORT, IOWA

*A single reading of this article will not suffice the ordinary reader. It must be re-read with attention.*

*Teachers interested in nucleonics who are not active in the field will appreciate this brief paper which summarizes a considerable number of investigations that have been made concerning mesons and their properties.*

The many mesons which have been described in the scientific literature during the past decade and a half make the condensation of such investigations somewhat of a necessity. We find listed the  $\pi$ -meson, the  $\mu$ -meson, the  $\rho$ -meson, the  $\sigma$ -meson, the longitudinal meson, the transverse meson, the heavy meson, the light meson, the fuzzy meson, and the latest discovered, the  $\tau$ -meson. Now most of these mesons can exist either as positive or negative, which brings the total number up to about twenty. To be sure there are not this many varieties; the number can actually be reduced to three or possibly four. It is the purpose of this paper to summarize briefly the investigations that have been reported.

Cosmic rays are probably the best source of mesons, in spite of the fact that mesons are at present being produced artificially in the laboratory. The origin of cosmic rays is ascribed to a type of process in which nucleons, possibly protons of very high energy, collide, much the same as in the artificial disintegrations in the cyclotron. Such collisions result in the emission of mesons.

Naturally, the first mesons to be observed and studied were those occurring in cosmic rays at sea level. These are properly known as  $\mu$ -mesons. They are sometimes designated as light mesons, longitudinal mesons, or  $\rho$ -mesons. The mass of the  $\mu$ -meson is 216 times the mass of the electron, and the charge is that of the electron, either positive or negative. Since these particles are radioactive, the  $\mu$ -meson is capable of undergoing decay. In such cases an electron and two neutrinos result.

Neutrinos have never been observed; but it is very logical that they exist, for otherwise the laws of conservation would not hold true in any of these processes. Photographs of nuclear capture of the  $\mu$ -meson are probably the most convincing evidence for the existence of neutrinos. In such cases the meson strikes the nucleus with no apparent nuclear disruption and with no evidence of any particle leaving the atom. To account for such phenomena, to avoid converting a system of particles from Fermi statistics to Bose statistics, to satisfy the spin problem as well as the conservation

laws, the existence of such a hypothetical particle as the neutrino seems very convincing.

Unlike the decay of mesons, which is common to both positive and negative particles, the process of nuclear capture is characteristic only of the negative meson. This is explained on the basis of the attraction of the positive nucleus for the negative meson. The significance of nuclear capture is important from the point of view of reactions of mesons and nucleons.

Interaction of slow negative mesons with matter consists of two steps. First, the meson is captured in the Bohr orbit with radius of the order of  $10^{-12}$  cm; secondly, the meson is destroyed by its collision with nearby nucleons. In condensed substances, conductors and insulators, a negative meson is captured in its orbit nearest to the nucleus in about  $10^{-13}$  seconds. In a gas the corresponding time is longer. In air this value is about  $10^{-9}$  seconds. Both of these intervals are considerably shorter than the natural lifetime of the  $\mu$ -meson, which is  $2.2 \times 10^{-6}$  seconds.

The ultimate manner of disappearance of the  $\mu$ -meson depends largely on whether or not such a particle would come in contact with a nucleus, or merely decay. Undoubtedly, such phenomena explain the observation made in a study of the energy spectrum at sea level in which the number of positive mesons is greater than the number of negative mesons by a margin of from 7 to 10 per cent.

The extreme penetrability of the hard component of cosmic rays is demonstrated in an experiment using coincidence counting. Two Geiger counters are arranged with their axes parallel to each other and perpendicular to the surface of the earth. The counters are placed at a constant distance apart and varying thicknesses of lead are inserted. It is observed that the number of coincidences decreases very rapidly as the thickness of lead is increased up to 8 cm. Beyond this value the decrease is much less pronounced. It is known that no electron of either sign can penetrate more than 15 cm. of lead no matter how great its energy. This is due to the Bremstrahlung effect. The coincidences received in this experiment after the thickness of lead increased beyond 15 cm. must be due solely to the mesons which are known to penetrate more than 100 cm. of lead.

Perhaps this extreme penetrability is in part due to the vast amount of energy which mesons possess. Provided they do not decay or are not captured, they lose energy only by ionization. The fast meson produces  $2 \times 10^6$  ion pairs per foot of water. This means an energy loss of about  $7 \times 10^7$  electron volts. By way of approximation, the energy loss of a meson traversing the entire atmosphere would be equal to  $7 \times 10^7$  elec-

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# Physics in Humor

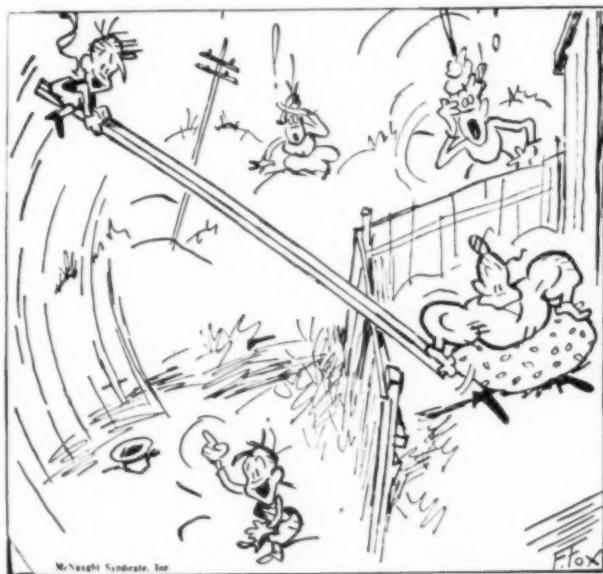
• By Robert S. Shaw

DEPARTMENT OF PHYSICS, THE CITY COLLEGE, NEW YORK, NEW YORK

Some readers are able to find in comic strips and cartoons more than interest and humor.

Physics teachers, for example, are sure to observe how the ideas and principles of their science are portrayed. Surprisingly, the physics so used is nearly always essentially correct.

A dozen years ago Professor Shaw began to collect comics involving physics. In this paper he tells how his collection has developed. A few of his favorites are shown.



Courtesy of Mr. Fontaine Fox.  
Fig. 1.

It has long been realized that illustrations of the ideas and principles of physics can be found in abundance in daily life. This is not so true of other sciences,



By Permission NEA Service, Inc.  
Fig. 2.

mostly because they are not concerned with events of the proper scale. Only physics is neither astronomical nor microscopic in the bulk of its concepts.

A corollary of the foregoing is that humorous situations will often be found to depend for their understanding on an appreciation of physics, in at least a qualitative way. Thus the practical joker who removes the chair at a crucial time may be deficient in his grasp of ethical principles, but he has a working knowledge of the principle of moments. The animated cartoons of the movies abound with exaggerations and sometimes violations of physical principles, especially involving angular momentum, elasticity, and sound. From time to time a gag told by a radio comedian paints a word picture which does the same.

Probably most readers have at times noticed that cartoons or comic strips made use of physics for laughs. After noting this fact casually, I began to collect such

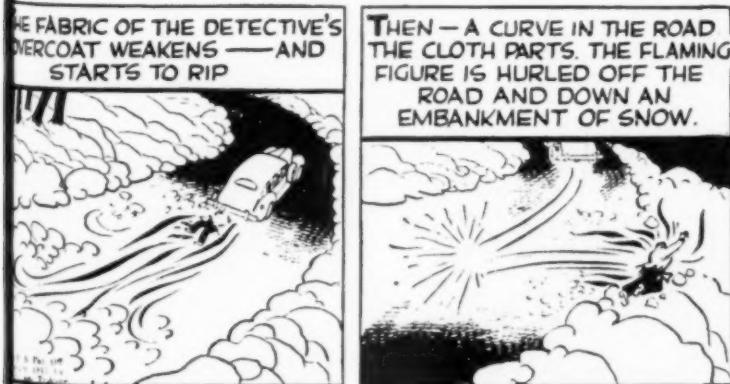


Fig. 3A.

Courtesy Chicago Tribune—New York News Syndicate, Inc.

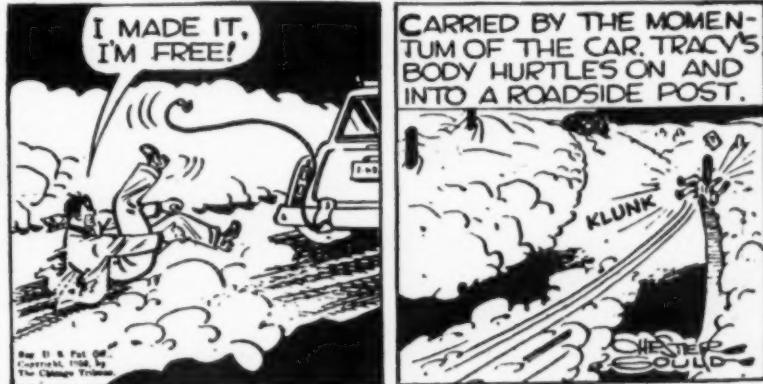


Fig. 3B.

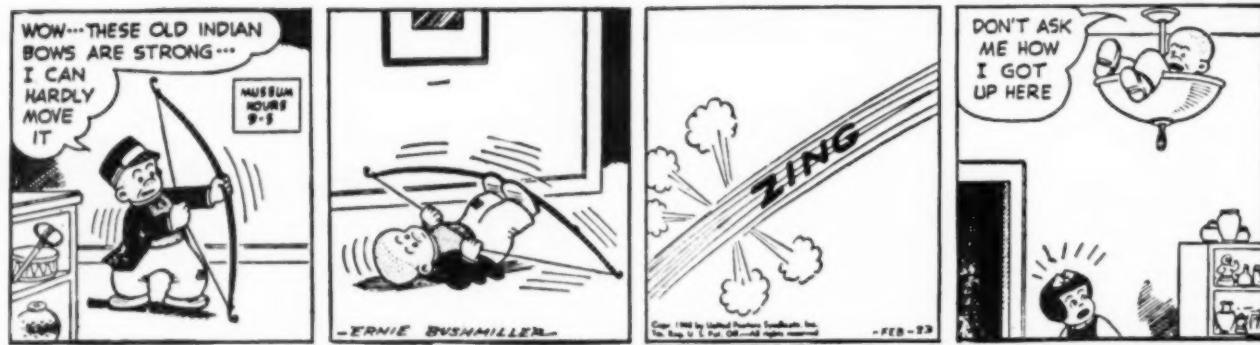


FIG. 5.

Courtesy of United Feature Syndicate.

cartoons systematically about twelve years ago. At that time it was my estimate that I should find about one a month, and thus that a single scrap book would last for several years with only one item on a page. Without any significant increase in the number of sources (two daily papers and four weekly magazines) I found myself collecting more than 100 items each year. To conserve space I sacrificed the appearance of my scrap books, crowding each page as full as possible. After a few years it became possible to select some of the best items, and these have been made into lantern slides so that they are available as lecture material.

This procedure is perhaps not the best one for using such a collection. Mr. John D. Woolever of Detroit, writing in *School Science and Mathematics* (April, 1950), states that he mounts his cartoons on large filing cards. He shows them by opaque projection, and by posting on a bulletin board. It is not clear just how long he has been collecting, but since he does not complain about lack of storage space, it is probably less than five years.

In order to give some notion of the possibilities in this field I have chosen a number of examples. These cover various topics in physics, but more important, they show several types of sources, and indicate how to find illustrations which the artist did not intend to provide.

Figure 1 is the simplest type. A single frame cartoon, it shows the

law of the lever in concise form. I have never seen an illustration with more than a fulcrum and two forces, but for that matter our students do not feel comfortable with a more complex case of moments.

In Figure 2, still a single frame cartoon, the words make a contribution. Such a cartoon may be considered to illustrate any one of several principles or topics, including friction, Newton's first law, in a sense the second law; there is even the suggestion that  $\text{power} = \text{force} \times \text{speed}$  (where speed here = 0).

One of the most remarkable facts to emerge from the years of collecting is the essential correctness of the physics used in cartoons. Such "exaggerations and 'violations'" as appear are generally clearly intentional, indicating both that the artist does, and that he expects his readers to, understand the physics involved. There are exceptions, and in Figure 3 we have an example with a happy ending. In 3A, the artist shows us

what our students, unfortunately, believe to be meant by "centrifugal" force. This was published in 1945. Five years later, the same situation occurred in the strip; that is, a "particle" which had been traveling in circular motion was set free. This time the artist shows what the teacher of physics knows to be the case. How the change came about I do not know; I had nothing to do with it.

When physics is illustrated in a comic strip (as distinct from a single frame cartoon) it



FIG. 4.



Courtesy of Ray Williams and Collier's.  
FIG. 6.

is usual that only some of the frames involve physics. The others are generally irrelevant, and in my collection I save space by cutting off the other frames. (Sometimes this will cause the date, or artist's name, to be lost.) Occasionally one finds a gem, such as figure 4, in which the whole strip can be used. This particular strip parallels quite exactly a well known demonstration with a copper wire. (No. M 63, in Sutton's *Demonstration Experiments in Physics*.) It involves Hooke's law (by implication), then the behavior beyond the elastic limit, and finally breaking strength.

It might be expected that physics would show up more often in strips devoted to fantastic adventures. I have not found this to be the case. A "death ray pistol," or similar equipment, is postulated rather than explained; or is described as depending upon principles not yet known on Earth. One of my steadiest sources is the strip shown as Figure 5, which involves ordinary kids using ordinary things (as indicated in the first paragraph



By permission. Copy. 1940. The New Yorker Magazine, Inc.  
FIG. 9.

of this paper). A very large number of cartoons and strips can be found to illustrate transformations of energy, and some even show conservation (insofar as that concept can be shown qualitatively). Most of these turn gravitational potential energy into kinetic energy. I present one which turns elastic potential energy into gravitational.

Figure 6 also illustrates energy transformations, but gets away from mechanical forms of energy. Also it involves two transformations explicitly. Other cartoons often show falling, bouncing and rising again; this is a closed set of changes. This is the only case I recall of an open set with more than two forms of energy involved.

The adventure strips sometimes illustrate physics. One which I see regularly is Superman. In Figure 7 there is shown a very substantial understanding of overtones and harmonic analysis. Incidentally, these look more like "forks" than actual tuning forks do. One suspects that the artist wished to avoid confusing his readers.

(Continued on Page 26)



Copr. 1950, Nat'l. Comics Pub., Inc.  
FIG. 8.

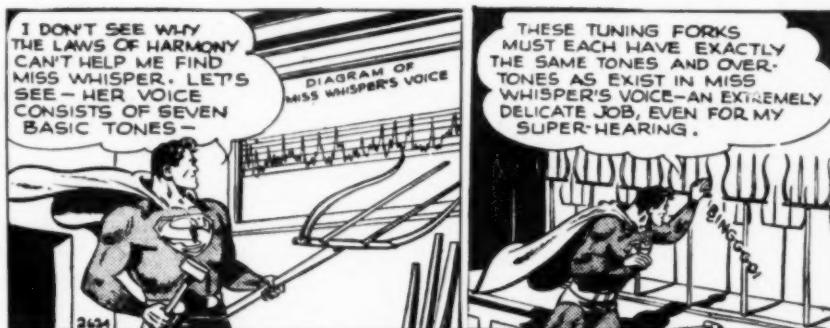


FIG. 7.



Copr. 1950, Nat'l. Comics Pub., Inc.

## Syracuse University Programs for the Training of College Teachers

• By **Robert Gaunt, Ph.D.**, (Princeton University)

CHAIRMAN, DEPARTMENT OF ZOOLOGY, AND ACTING CHAIRMAN, COMMITTEE ON THE PREPARATION OF COLLEGE TEACHERS IN SCIENCE, SYRACUSE UNIVERSITY, SYRACUSE, NEW YORK

*There are many first-rate researchers who teach well. There are other scientists who are ineffective teachers. Possibly it is because they have not been trained in the skills and techniques of teaching. They do not have a proper background in educational history and philosophy. They do not know the tricks of the trade.*

*Some relief will be afforded by the new doctorate programs for the training of college teachers that are being offered at a few universities.*

*Here is a description of the work being done in the natural science program at Syracuse.*

will be readily captured and reduced to curricular form. The "born teacher" must pursue his individualistic way. He can, however, impart much of his skill to apprentices who study carefully with him.

The specific provisions of the new programs require (a) a course in Higher Education in the U. S., (b) a continuing seminar under a dual professor of science and education in science teaching methods, and (c) teaching experience in some general education science courses at Syracuse or elsewhere under the supervision of the professor involved. Before a candidate is allowed to take his Ph.D. qualifying examination his graduate advisory committee, on the basis of all information that it can obtain, must certify his probable prospective competence for the job of college teaching.

The new programs offer another and perhaps more important innovation. They are designed to substitute breadth of training in subject matter for intense specialization. As Chancellor William P. Tolley, of Syracuse, likes to express it, they are to train generalists rather than specialists. Newer trends in American undergraduate education have shown a striking need for such broadly trained college teachers. Many institutions, including Syracuse, are introducing courses and programs for undergraduates in *general education*. Details of their nature are not germane here. Suffice it to say, however, that they cut widely across traditional subject matter lines. One great impediment in their development has been the lack of teachers trained broadly enough to handle them.

To achieve this end the regular departmental requirements for degree sponsorship in the sciences has been broken down, and a student electing the college teachers' program is sponsored by two or three departments. His program is prepared with the help of an inter-departmental committee, and depending upon his background he will be advised to take a block of courses from the offerings of the different departments concerned instead of concentrating in any one department. In addition he is required to take courses in the history and philosophy of science.

The amount and type of research training that should be included was studied carefully by the large faculty committee which devised the new programs. It was recognized that institutions of higher education have the two-fold purpose of disseminating knowledge and of discovering or creating new knowledge. The usual Ph.D. program emphasizes the latter. The committee decided that measures introduced to add training in teaching competence should not encroach upon those creative aspects of scholarship. Such a move would only dry the well of higher learning at its source.

*(Continued on Page 31)*

Syracuse University has launched three new doctoral programs for the training of college teachers. They reflect the trend of a new development in graduate education. The first student trained in one of these programs—that of social science in Syracuse's Maxwell Graduate School of Citizenship and Public Affairs—received his degree in January, 1949. Related programs, started later, are now operating in the humanities and the natural sciences.

One of the major functions of graduate schools always has been to train college teachers. It is a curious fact, however, that the traditional Ph.D. programs concentrate on subject matter and research training and provide only informal provision for acquisition of the skills of teaching. Admittedly knowledge of subject matter is the most important element of the college teacher's equipment. No attempt is being made at Syracuse to substitute method for content. It is at times sadly self-evident, however, that knowledge of subject matter alone does not make a successful college teacher. Subject matter has to be garnished with perspective and wisdom, and a little added wit does no harm. The method of presentation has about as much to do with the result as the content itself.

One purpose of the new graduate programs is to provide some formal training in that educational history and philosophy which is the basis for the American experiment of offering higher education to the millions. Another is to provide training in the specific skills and techniques of college teaching. The use of certain classroom practices and policies are generally recognized to improve the work of any teacher. They are usually learned by trial and error and at the expense of students. It is not, on the other hand, anticipated that those subtle and highly variable qualities which distinguish great teachers from good teachers

# Baseball Bat Chemistry

• By T. H. Whitehead, Ph.D., (Columbia University)

PROFESSOR OF CHEMISTRY, UNIVERSITY OF GEORGIA, ATHENS, GEORGIA

*You may not be aware that considerable chemistry is involved in making a good baseball bat.*

*This off-the-beaten-track article shows how the chemist is concerned in seasoning the wood, controlling its moisture content, and protecting it from insects. He knows how to increase the strength of the bat while preserving its resiliency. He has learned what fillers to use, and what lacquers, varnishes and stains are suitable.*

*The writer of this paper has long served as a consultant to a large manufacturer of baseball bats.*



There was little connection between baseball and chemistry in the public mind until recently, when a motion picture was made about a young chemistry teacher who accidentally discovered a mixture that caused a baseball and bat to mutually repel each other. Although this theme was interesting, it was fantastic and a far cry from the real application of chemistry to baseball bats.

When you see a player knock a home run in a close game, you are likely to give him all the credit, but his bat had a lot to do with it. The professional player knows this, and is very careful in selecting his bat. He demands a certain weight, shape, and length. The bat must be perfectly balanced, and above all it must be resilient. To make each type of bat requires rigid control, from the selection of the raw wood to the final finishing of the bat, and chemistry plays an important role in this manufacturing process.

## The Wood

Most baseball bats today are made of ash wood although some playground bats are made of hickory. The trees from which the wood comes are carefully selected in the forest. Each piece of wood must be flawless. It must have an even grain, no holes caused by insects, and no knots.

The tree is cut into logs, and then into cylinders. These are shipped to the bat manufacturer long in advance of the time when the bats will be made. All kinds of insects are lying in wait for this nice fresh wood. War must be declared on them. The manufacturer depends upon the chemist to supply him with insecticides to repel and kill these insects before they can do irreparable damage. Paradichloro-benzene and DDT have solved this problem, but constant inspection is necessary.

Another serious storage problem is the control of moisture. The wood is capable of taking up or losing

moisture if the atmosphere contains varying quantities of moisture. Changes in the moisture content of the wood might cause warping and make the cylinders useless for bats. In the plant of the Hanna Manufacturing Company of Athens, Georgia, the wooden cylinders are checked periodically for moisture content. An instrument having two needles is stuck into the wood, and the conductance of an electric current is read on a calibrated dial. Since the conductance varies with the moisture in the wood, its moisture content is determined directly.

## Treatment of Wood with Chemicals

A baseball bat receives rough treatment during its lifetime. It is exposed to the hottest sunlight, to rain, to storage in damp shower rooms and in canvas bags. Naturally, it receives constant impacts when it meets baseballs and when it is pounded on the ground by an irate batter.

The Hanna Company discovered and patented a process for forcing a liquid adhesive through a bat to obtain greater strength and at the same time to retain the resiliency of the wood. This adhesive must be carefully regulated in its preparation and application to obtain uniform results. It must also become water-resistant after it has set, and this requires an additional chemical.

## Making the Bat

No chemistry is involved in converting the wooden cylinder into a baseball bat, but the process is interesting. First, a model is made on a hand lathe by a master craftsman. A micrometer is used to measure the exact shape and length of each model. Then a master lathe is set to these dimensions and other lathes are set in series with the master lathe. Workmen then push a wooden cylinder into each lathe and a bat of that model is cut. In this way bats can be turned out by ordinary workmen. It is a good example of American mass production of a quality product.

The bat could be sanded and used just as it comes from the lathe but Americans want their products "dressed up" in pretty colors. Furthermore there is a good bit of superstition among professional baseball players about the appearance of a bat. If a man knocks a home run in a World Series game with a brown bat, brown bats will be in demand at once. If on the other hand, he strikes out at a critical time with a brown bat, even Arthur Godfrey would have a hard time selling them the next day. The manufacturer must guess in advance what colors will be in demand each year, and he must do this long before the baseball season begins. If he guesses wrong, he will have a lot of bats unsold and once the bat is finished, it is not practical to change it.

Sometimes the manufacturer gets peculiar orders. A large city once ordered bats for its playgrounds to be colored green on the upper half and yellow on the lower half. This odd appearance discouraged stealing of the bats from city playgrounds.

All manufacturers of wood products are faced with a similar problem but the baseball bat manufacturer has two difficult ones. His treatment must not raise the grain of the wood, and it must not warp the wood at all. A furniture manufacturer could dip his wood in a water stain for hours, but the baseball bat can be dipped for only a few seconds, or a few minutes at the longest.

**W**ood is a porous material and therefore it must be "filled." That is, some material must be rubbed into the outside surface to fill the porous grain and insure a smooth, uniform appearance. There is a wide variety of these wood fillers but the filler must be chosen to suit the stain to be applied later. Some fillers contain whiting, barium sulfate, gum arabic, linseed oil and glue. Others contain a nitrocellulose base, artificial resins, driers, and a solvent such as ethyl lactate. Still others contain starch, shellac in alcohol, or many other chemical products. After filling, the bat is sanded to a smooth finish before it is stained.

#### Finishing the Bat

Most people like to see the grain of wood in a bat, so opaque finishes such as paint are never employed. Clear lacquers, clear varnishes, and stains are used. In some woods, such as hickory, the grain is not uniform in color, so a bleaching operation is performed before coloring. Concentrated solutions of hydrogen peroxide are very effective for this purpose.

Water stains have been used successfully. This may be a water solution of an organic dye, or a water solution of an inorganic chemical which precipitates a colored product in the wood. For example, a variety of brown colors can be obtained with a water solution of potassium permanganate, by varying the concentration of the solution, or its pH, or by adding a catalyst.

Spirit stains are also widely used. These consist of an oil-soluble dye in a suitable solvent, such as denatured alcohol or mineral spirits. Care must be exercised in selecting the dyes to avoid any which cause skin allergies, because it is impossible to completely insulate the workman from the stain.

Colored varnishes are used on some high grade bats and give a beautiful finish. Lacquers can be sprayed on to produce very attractive finishes but the expense involved usually limits such treatment to the higher priced bats.

It is evident that a lot of chemistry is involved in "dressing up" a bat to make it attractive to prospective customers.

#### The Final Step

The final step in finishing a bat is putting a brand on it, and in some cases providing a firm grip for the batter. Some chemistry is involved in this because the brand usually contains color. The color may be obtained by inserting thin sheets of metal between the die and the bat. When the die is impressed on the bat it carries a film of metal with it, and thus imparts a color to the brand. The brand must be located carefully on the bat because the batter is supposed to hold the bat with the brand facing him in order to get the greatest resiliency from the bat.

For many years a baseball bat was one of the few pieces of athletic equipment having a smooth grip. Golf clubs, tennis racquets, polo mallets, and even table tennis paddles are provided with a grip. This may be done by wrapping leather around the handle or by grooving the handle. Baseball players often use dirt or rosin to provide greater friction between hands and the handle of the bat.

Softball bats must have safety grips, and the research that has gone into developing grips for these bats has been applied to other bats. A good grip provides friction but it must not injure the hands in any way. It must withstand perspiration and constant use.

**F**INELY ground cork which has been mixed with an adhesive and pressed into sheets makes a good grip, particularly when it is perforated with small holes. Rayon waste has been mixed with clear lacquer and sprayed on bat handles. The appearance of felt can be obtained in this way and a variety of colors obtained. Several types of adhesive tape have been developed for baseball bats and these are superior to the surgical adhesive tape which many players themselves apply to bats. Adhesive tape permits a firm grip which does not cover the entire surface of the bat handle. However, many players still prefer a smooth handle to allow them to shift the position of the hands quickly while batting.

Chemistry is thus involved in almost every step of the manufacture of a baseball bat. I can testify that some of the applications of chemistry to bat manufacturing have been difficult problems to solve because I have served as a consultant to the Hanna Company for many years. ●



"A college is a contrived means of bringing to bear maximum beneficent influence to produce maximum progress in the individuals concerned. Ideally, the members of college, both teachers and taught, *work* together, *think* together, *play* together and *pray* together. We must not let our praying remain separate from our thinking or our playing be wholly dissociated from our working. It is the wholeness of life that we consciously and deliberately seek."

—D. ELTON TRUEBLOOD  
Earlham College

# Nickel in the Modern World

• By **W. D. Mogerman**

EDITOR "CORROSION REPORTER," THE INTERNATIONAL NICKEL COMPANY, INC., NEW YORK

*Too often we are inclined to undervalue the familiar. Possibly this is true of nickel.*

*Persons not in direct contact with the industry are not likely to appreciate the valuable qualities of this common metal, or to be aware of its large, varied, and expanding uses.*

*The author of this paper writes from first-hand knowledge. He tells an interesting story.*

Nickel was discovered in a sample of *niccolite* by the Swedish chemist Axel Fredrik Cronstedt in the year 1751. We will soon be able to celebrate the 200th anniversary of its recognition as a chemical element. This recognition was by no means immediate.

Many contemporary chemists were at first inclined to look upon Cronstedt's new element as a mere mixture of older and well-known materials. The strong magnetism exhibited by the new material was accepted by some skeptics as evidence it was composed of iron plus other impurities. Some investigators who tried to duplicate Cronstedt's observations worked

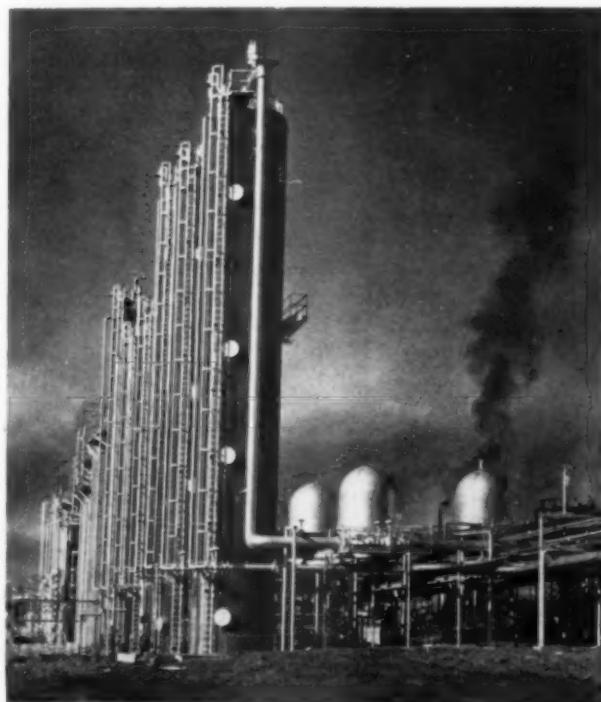
with samples so high in impurities that they professed to detect no magnetism at all in the new element. Others, who were impressed by the strong blue color of nickel salts in ammoniacal solution, concluded that the new material must be copper, more or less impure.

Evidence against the likelihood of a new element was also produced from alchemical theories. In those days only six "true metals" and six "semi-metals" were known, and it seemed to some old-fashioned observers that this total of twelve completed the number of metals required by Nature's plan, because there are only twelve signs in the zodiac. This logic seems strange to us today, when 98 elements are known, and more artificial elements of the trans-uranium series are added from time to time. The matter was also not clarified when some chemists of the day explained that one element slowly turned into another by obscure operations. In self-defense, Cronstedt felt forced to point out that there were already more metals known than there were planets revolving around the sun; consequently there might easily be one more metal, the zodiac notwithstanding; and even other metals might remain to be discovered. He modestly placed nickel among the "semi-metals."

The controversy over the existence of nickel continued for more than a half-century. Then, during the early years of the 19th Century, some relatively pure samples of nickel were obtained by investigators in France and Germany; the chief chemical and physical properties were described with considerable exactness, improved analytical procedures were worked out, and the scientific world ceased to question the separate existence of nickel as a chemical element.

But the problem of obtaining nickel in a uniformly malleable condition and in commercial amounts continued to plague metallurgists for many years. In the course of time fairly good empirical methods for refining nickel, and for overcoming the brittleness due to impurities, were worked out in various parts of the world, and nickel slowly entered upon its industrial career during the latter part of the 19th Century. However a truly scientific explanation of the causes of brittleness was not achieved until the early years of the 20th Century, and it may be said with much truth that nickel reached maturity in the industrial sense only during the last half-century.

Even as far back as a century ago, modest quantities of nickel were used for the manufacture of nickel silver or "imitation paktong" as it was once called, for electroplating, and for coinage alloys. Many nations produced small amounts of nickel from low-grade ores. Authorities have estimated that the total annual production of nickel never exceeded 200 tons prior to 1870. Norway was the world's most important producer until about 1877, when it was succeeded by New



FLUID CATALYTIC CRACKING EQUIPMENT used in a petroleum refinery and containing resistant nickel alloys.

Caledonia with its rich deposits of garnierite (silicate type) ores. New Caledonian production led the field until about 1903, when the Canadian pyrrhotite-chalco-pyrite (sulfide type) ores of the Sudbury Basin took the leading position, which is still maintained.

During the 19th Century the growth of the nickel industry was very slow, due primarily to small-scale, primitive, and laborious production methods, which led to relatively high prices, and to a very limited market. The initial impetus for development of the Canadian nickel industry came after about 1890, when the United States Government purchased a large quantity of nickel for the production of naval armor plate; and for a number of years the production of tough and strong nickel steels for armaments remained the principal outlet for nickel. After World War I the Canadian nickel industry, not wishing to be dependent on Mars for the bulk of its business, actively and decisively turned toward the development of peacetime applications through research. Research and development work on a considerable scale was undertaken in the laboratories of The International Nickel Company and the Mond Nickel Company. This policy, initiated in the early 1920's, has proved remarkably successful, for since that time the demand for nickel has unfolded into a myriad of direct and indirect applications to meet the needs of civil life, while military requirements have, of course, not been neglected.

Production figures for Russia have not been available in recent years, but for the rest of the world total production was estimated at 130,000 short tons per annum for the year 1948. In that year about 120,000 tons were produced by The International Nickel Company of Canada. In recent years the production of nickel from Canadian mines, which supply the major share of world production, has remained in the neighborhood of 100,000 short tons per year, rising to 140,000 tons during the war years. Let us consider a few of the most important uses for this appreciable amount of metal.

One of the earliest applications of nickel, and still one of the most important in weight of metal consumed, is electro-plating. Many readers now in their middle years can recall the attractive nickel-plated trim on kitchen stoves, bicycles and automobiles that they saw as children. An electro-plated nickel coating is not so often visible nowadays, because it is now more generally employed as an essential undercoat to chromium. It has been found that the chromium coating so popular on modern decorative ware supplies a harder and more durable finish if it is deposited upon a good foundation coating of nickel. The electro-deposition of nickel in heavy layers has also been applied by the engineering industry for the building up of worn machinery parts. In some instances, piping for chemical and process plants, which require only a limited degree of protection against aggressive reagents, receives a thin coating of electro-deposited nickel on the exposed surfaces.

Coinage represents another important application. Coins of pure nickel are now used in many countries

and nickel alloy coins in many more. The careful native of India, for instance, needs no longer bite a *rupee* to test its genuineness, which was always a rather indecisive test. Instead he can apply a small magnet, which he may carry on a string around his neck. If the proffered coin bears the familiar white color and is hard, sharply defined, uncorroded and also magnetic, he knows that it is a genuine Indian Government issue of pure nickel and therefore acceptable.

The observations that the wise Hindu thus makes on a nickel coin to avoid counterfeits may seem rather homely, yet they will suffice to bring out in a simple fashion some of the most important reasons for the modern applications of nickel revealed by research. Nickel is a very ductile metal, possessing strength and hardness to almost as high a degree as low carbon steel. It therefore will not deform with hard use. When it is added to other metals in alloys there is generally a considerable improvement in mechanical properties; for example, nickel-steels containing even a low percentage of nickel exhibit a higher yield strength than is usual with carbon steels and thus permit smaller sections to be used in structures, which makes for decreased weight, an economy feature of importance. The clean surface noticed by our Hindu is a very important consideration in the pure metal as well as in many alloys containing nickel, for it betokens resistance to corrosion, even in the trying atmosphere of his native land.

The excellent resistance of nickel and its alloys to the attack of certain alkalis, acids, gases, food products and many other corrosive substances has made a success of many chemical engineering operations, some of them once considered prohibitively destructive of equipment. Also, the manufacture of many modern pharmaceutical products which require extreme purity, such as antibiotics, biological extracts, and other high grade drugs, often call for the use of resistant equipment made of stainless steel, Inconel, or other nickel

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A MODERN RAILROAD TRAIN made by American Car and Foundry Company. Much nickel steel and stainless steel are used.

# The Photoflash Lamp

• By **Frank G. Brockman, Ph.D.**, (University of Pennsylvania)  
PHILIPS LABORATORIES, INC., IRVINGTON-ON-HUDSON, NEW YORK

*The disturbing noise and the billowing clouds of white smoke that once made flashlight photography dangerous and unpleasant are no more.*

*Each year the United States manufactures 150,000,000 of the photoflash lamps that are such a boon to both photographer and photographed.*

*Read here how the lamps are constructed and how they operate.*

Sir William Crookes appears to have been the first to have used burning magnesium as a light source for photographic purposes. This he did in 1859. From that date to the present, light sources of this general nature have continued in favor.

As the photographic art progressed, the "flash" light has undergone a slow evolution. The rapid burning of a powdered metal in an open container led to the use of powdered magnesium. Later, aluminum powder replaced the magnesium wholly or in part. Air as a source of oxygen was replaced by other oxidizing agents such as potassium chlorate or perchlorate. Considerable ingenuity went into the development of devices for burning the flash powder. But, despite all the effort expended, rather important disadvantages remained. These were chiefly the hazard of fire, the noise of the flash, and the voluminous white smoke generated.

The removal of these disadvantages by the obvious—as it seems to us today—expedient of enclosing the combustion within a transparent envelope was some time in arriving. The early attempts at this were made in about the decade from 1920 to 1930, and finally the foil-filled photoflash lamp was introduced to the American market in 1931. This lamp consisted essentially of a crumpled sheet of very thin aluminum foil enclosed in a glass bulb together with oxygen gas in excess of the stoichiometric amount. A short filament, supported inside the bulb on a pair of current leads, was used to electrically initiate the combustion.

Because of the high thermal conductivity of aluminum it was important for the foil to be very thin so that local heating of the foil could be great enough to reach the kindling temperature of the aluminum. The foil used was about  $4 \times 10^{-5}$  cm. thick and was prepared by gold beaters' methods. This was a drawback for the foil flashlamp because it made the filling material costly. Another fault with this type of lamp was the fact that the foil usually began to burn locally so that in certain stages of the burning the unburned foil acted as a shield for the light generated.

The wire filled photoflash lamp now common was introduced in about 1936. This design eliminated the two shortcomings of the foil lamp: the filling material

was much cheaper, and the screening of the light by unburned material was greatly reduced.

The wide acceptance of the photoflash lamp is reflected in the astonishing production figures. It is estimated that in 1948 and 1949, total production in the United States was about 150,000,000 photoflash lamps per year.

Aside from the numerous technological problems in the manufacture of photoflash lamps, there are some of a more fundamental nature.

All of us are acquainted with a number of processes in which energy of one form or another is transformed into radiant energy in the visible region. In the incandescent lamp electrical energy is transformed, and the transforming agent is the tungsten filament which obeys, more or less, the radiation laws for a black body. In this case the source is an incandescent solid. The visible radiation from a neon light has its origin in individual atoms of the neon gas. Under the influence of an electric field, an electron in the atom is moved from its normal energy level to some higher level. In returning from this unstable state to the normal state, energy is liberated, and the wavelengths of this energy are characteristic of the element neon. Some of this energy is in the visible region. In this case the emitter is an excited gaseous atom. The phosphor on the face of a cathode ray tube or in a fluorescent lamp glows with a more or less characteristic radiation because certain ions within the crystal lattice of the phosphor are similarly raised to an upper energy level by electron bombardment or by the absorption of other radiation. The return of the excited ion to its normal energy state is accompanied by the radiation of energy. Here the source is an excited ion within a solid crystal lattice.

The remarks just above pointedly raise the question: what is the nature of the emitter in the photoflash lamp?

Spectrographic studies have furnished information which enables one to draw a conclusion regarding this question. The spectrographic evidence is as follows:

1. By a special arrangement it was possible to record the spectrum of the light emitted by a photoflash lamp as a function of time throughout the entire duration of the flash. (The total time of the flash was about 60 milliseconds.)

The outstanding characteristics of spectrograms obtained in this manner are:

- (a) A band spectrum from about 5400 Å to 4400 Å, identified as the spectrum of A10.
- (b) Aluminum lines at 3944 Å and 3961 Å. These lines invariably broaden as the flash progresses and have been observed to reverse during the latter part of the flash.

- (c) A broad reversed line at about 3720 Å. This is due to the absorption of the unresolved three most sensitive lines of the arc spectrum of iron.
- (d) A line at 4045 Å which broadens and reverses as the flash progresses. This is from the unresolved third and fourth most sensitive lines of the arc spectrum of potassium.
- (e) A broad absorption about 50 Å wide at about 5000 Å. Since this absorption did not appear in the spectra from lamps charged with aluminum but only from those with aluminum-magnesium alloy, we have tentatively ascribed this to a reversal caused by MgO, since the strongest bands of the MgO emission spectrum appear at 5007 Å.
- (f) A line due to the unresolved yellow sodium doublet.

From these observations, we may conclude that a substantial portion of the radiative process takes place from substances which are in the vapor phase. This conclusion can be based on the behavior of the aluminum lines alone. In the early part of the flash, when the vapor pressure is relatively low, the lines are sharp. As the flash progresses these lines are broadened. This broadening can be attributed to increasing vapor pressure. The reversal occasionally observed indicates that the combustion process is, in these cases, occurring in a region such that the radiation traverses a path of aluminum vapor not yet involved in the combustion. At the end of the flash, when the visible radiation has diminished to a low value, the pressure-broadened lines again become sharp as the vapor pressure diminishes. The presence of the bands of aluminum oxide throughout the entire duration of the flash demonstrates the presence of aluminum oxide in the vapor phase.

The presence of elements other than aluminum and magnesium is due to the ignitor and to impurities from the lead-through wires and the glass.

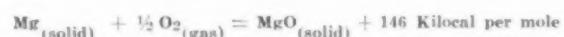
2. If a spectrogram, taken over the full time of the flash, is analyzed for the distribution of energy throughout the spectrum, and if the results obtained are compared with the energy distribution of a black body, then one is led to the conclusion that the flash is equivalent to a black body at 4000° K.

The fact that the equivalent radiation temperature that is attained approaches 4000° K leads us again to the conclusion that the radiator is a body of luminous vapor. As nearly as one can predict from the available data, all reactants and products within the bulb are in the vapor phase at the equivalent temperatures indicated by the radiation curves and the probable pressures existing during the flash.

**I**N ADDITION to the question of the nature of the emitter treated above, there is also that of the kind of energy which is transformed in the process. In the processes mentioned earlier in this article, the energies transformed were electrical, in the incandescent lamp and the neon lamp; kinetic (of the electron) in the cathode ray tube; and radiant energy of wavelength different from that of the emitted light in the fluorescent lamp.

Consideration of this question quickly leads us to the conclusion that the electrical energy used in the filament of the photoflash is not really the source of the radiant energy but merely that which initiates the process. The real source is chemical energy. The process of the combustion of aluminum or magnesium to form the corresponding oxide is accompanied with the liberation of considerable amounts of energy. It is this energy which heats the vaporized materials to incandescence.

It has been found that photoflash lamps charged with magnesium-aluminum alloy wire have a greater actinic effect than comparable aluminum lamps. It might be expected then that this difference could be demonstrated in the relative heats of formation of magnesium oxide and aluminum oxide. This is not the case, the heats of formation are given as follows:



On the molar basis for the reacting metals this corresponds to 146 Kilocal. for one mole of Mg and 190 Kilocal. for one mole of Al. On the basis of the energy per gram there are 6.1 Kilocal. per gram of Mg and 7.0 Kilocal. per gram of Al. So that the actinic superiority must be explained in some other manner. Perhaps the lower boiling point of magnesium as compared with aluminum, or some other thermal differences, as for instance, the heat of vaporization of the respective oxides, are the important factors.

**T**HREE ARE two other features of the present day photoflash lamp which are of interest to the chemist.

The ignitor in the flash bulb is not only the incandescent tungsten filament but is primarily a coating placed on the filament and also as two small beads at the junction of the lead wires and the filament. This coating is made of a paste containing a readily combustible metal, like magnesium, and an oxidizing agent. When these beads and the coating are heated, a small explosion occurs which scatters incandescent particles throughout the volume of the bulb. These particles serve to ignite the wire at numerous points.

Finally, there is to be found in some types of bulbs a tell-tale mark which is included within the bulb to give evidence of a leak. Although the oxygen in the bulb is stoichiometrically in excess of the amount required for the combustion of the wire, the net pressure within the bulb is less than atmospheric. If a leak occurs in the jacket the pressure will rise to atmospheric, and firing the bulb under this condition will probably result in fracturing the bulb. The tell-tale mark is a version of the weather-guide familiar to many. That is, the mark is painted inside the bulb with a pigment containing a cobalt salt. In the filling operation the cobalt salt is dehydrated and the color is the characteristic blue, but if air leaks into the jacket,

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# A Photo-Electric Slave Unit

• By Harry F. Osterman

PHYSICS '51, CARNEGIE INSTITUTE OF TECHNOLOGY, PITTSBURGH, PENNSYLVANIA

The commercial photo-electric slave units that are used to trigger photo-flash bulbs are expensive and complicated and do not synchronize well at very high speeds. To obviate some or all of these difficulties would be a worthwhile accomplishment.

Here is an account of how a physics major solved all three problems by devising a simple, low cost slave unit that anyone can build.

The accompanying illustrations were provided through the courtesy of Professor Charles Williamson, who directed the project, and "Carnegie Technical" in which an account of the study first appeared.

In order to get a high grade picture and one of high contrast, photographers find it necessary to use several flash bulbs located away from the camera and so adjusted that their areas of maximum illumination fall on different parts of the subject. The usual method of accomplishing this is by connecting the external flash units in series with the main unit at the camera by means of several lengths of lamp cord. Although this method works very nicely, it is difficult to use this arrangement where there is much pedestrian traffic, since under such conditions the danger to the equipment is very great. People always seem to find some way to trip on the cords.

Another method is that of a photo-electric slave unit. A photo-electric slave unit is a circuit whose express purpose is to trigger photo-flash bulbs by picking up the flash of one such bulb with a phototube and sending the impulse through the proper circuit to flash another bulb. By the use of such a device it is possible to accomplish the same effect as that produced by the wire connected units. The slave units can be placed at any point in the room and they will function so long as the phototube can see the initial flash.

Although slave units work well for pictures that are taken at shutter speeds of about 0.01 seconds, the flashes do not synchronize well at speeds that exceed that value by any great amount. This, plus the fact that the units are rather bulky and complicated, makes them technically uneconomical. The price, in the neighborhood of one hundred dollars, is also a big factor in preventing many people from obtaining the units.

The work done by the author was carried out in the Vacuum Tube Circuits laboratory at Carnegie Institute of Technology under the direction of Professor Charles Williamson. He approved it as a project provided that it was aimed so that one of the previously

mentioned difficulties in the existing slave units would be made small enough that the unit would become more practical. One of three things had to be accomplished: the synchronization improved, the unit made smaller and simpler, or the cost reduced.

Most of the units in existence at the beginning of the experimentation used a relay to fire the flash bulbs. A phototube was employed to trigger a triode amplifier, which in turn activated a high resistance relay. Due to the use of the relay, the time lag in the operation of the circuit was considerable, being on the order of 10 to 20 milliseconds. It is obvious that such a time delay could easily affect the range of shutter speeds that could be used in conjunction with the slave units. A suggested method of increasing the range of shutter

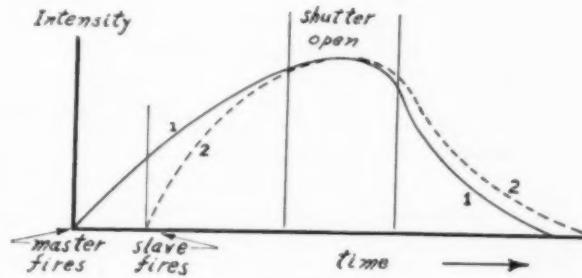


Figure 1.

speeds while using a slave unit is by the utilization of flash bulbs which require a different time to reach a peak of brilliance. The method used is as follows: a flash bulb that can be used for certain ranges of shutter speeds is placed in the master unit on the camera, while a bulb that has a shorter peaking period is used in the slave unit. This shorter peaking period in the slave unit bulb compensates for the time lag of the relay, thus allowing the photographer to use higher shutter speeds (Fig. 1). Although this method seems ideal, there are two limitations. First, it is a nuisance to carry the various types of flash bulbs, and second, there is no assurance that the reaction time of the relay will remain constant.

As has been stated, the time lag in the circuit was due to the use of a relay. The problem that presented itself was that of finding a method of firing flash bulbs by some means that did not have such a large time lag. It was obvious that some type of electronic circuit must be used, but what kind? The first circuit that suggested itself was a triode amplifier. However, this proved impractical due to the fact that a triode could not be found that could carry the needed firing current, one-half ampere, and still remain feasible in size and price. Consequently, a circuit that used a thyratron tube was devised.

A test circuit was first set up on a breadboard for experimental purposes. In this test circuit a 2D21 thyrotron and a 930 phototube were used. The 2D21 is a tetrode, and it was found that its grid potentials were quite critical. It was necessary to find the potential at which the screen grid had to be held so that firing would occur when the phototube was activated by another flash bulb, but not when the phototube was subject to ordinary room illumination. At first a voltage divider circuit was connected to the screen grid so that its potential could be varied to allow for ambient conditions. However, the experimenters noticed that this potential was not too much greater than that of the cathode, and it was decided to test the tube with the screen grid connected directly to the cathode. This worked quite satisfactorily. When the screen grid was held to cathode potential it was found that a 22.5 volt negative bias had to be applied to the control grid to keep the tube from firing under normal illumination. When illumination whose intensity was on the order of that of a flash bulb was seen by the tube, the potential that it developed across a five megohm resistor was sufficient to drive the control grid potential to a point where it would trigger the thyrotron. The plate potential of the thyrotron was adjusted to 135 volts.

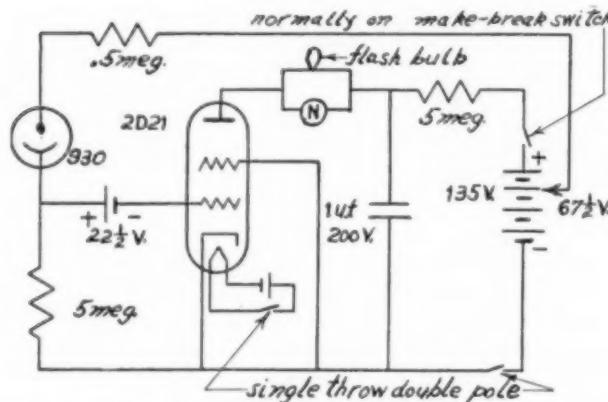


Figure 2.

Originally the flash bulb was fired directly from current drawn from the plate battery, but the large current that is necessary to fire the flash bulb proved to be too much of a load on the plate source and greatly shortened the life of the battery. It was then decided to make use of an R-C storage circuit to correct this. The one microfarad condenser shown in the diagram is charged through a five megohm resistor, and when the unit fires, most of the firing current is drawn from the condenser, thus greatly increasing the life of the plate battery. We now had enough data to design the slave unit circuit in its final form, which is shown in Figure 2.

To place the unit in operation, one has only to throw the on-off switch to "on," and place the unit in such a position that the phototube can see the initial flash of the master unit. Only one-eighth to one-quarter of the cathode of the 930 needs to be illuminated to cause

the circuit to fire. Indeed this tube is so sensitive that it will fire from the reflection of the master flash in a blackboard. In order that the unit might be tested before actually using a flash bulb, a neon indicator lamp was placed in parallel with the flash bulb. To make a test, we had only to strike a match before the 930 to light the neon bulb. After the test has been completed the "make-break" switch is momentarily opened to deionize the thyrotron and insure that a premature firing of the flash bulb will not occur when it is inserted in its socket. After inserting the bulb, the unit is placed in the desired position and is ready for operation.

Because the time lag in the completed circuit is in the order of a few microseconds, the synchronization of the separate flash bulbs is very much better than has been achieved before. The circuit has been built into a small utility box six inches on a side. This is possible because all the components with the exception of the phototube are of the miniature type. In comparison with commercial apparatus this circuit is much simpler, requiring fewer and less expensive components, costing about fifteen dollars. Thus all three of the initial objectives have been achieved, and we have developed a simple, low-cost slave unit which anyone can build. •



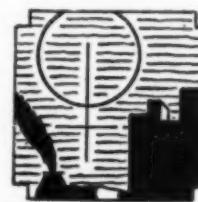
## A New Physics Digest

Here is a valuable new instructional help for teachers of physics.

Late in 1950, the W. M. Welch Manufacturing Company published Volume I, Number 1, of *The Welch Physics Digest*. The journal is attractive in appearance and interesting in content. The current issue contains digests of articles from a number of journals including *American Journal of Physics*, *School Science Review*, *School Science and Mathematics*, *Popular Science*, *The Science Teacher*, and *Scientific American*.

Dr. Ralph W. Lefler of Purdue University will be responsible for selecting and digesting the articles for publication, sifting them from the many articles on physics published throughout the world.

The *Digest* is sent free on request. The Welch Company may be addressed at 1515 Sedgwick Street, Chicago 10, Illinois.



## Contact Lenses

• By **L. Lester Beacher, O.D., O.Sc.D.**, (Northern Illinois College of Optometry)

CHAIRMAN, CONTACT LENS SECTION, STATE OF NEW JERSEY, AMERICAN OPTOMETRIC ASSOCIATION, EAST ORANGE, NEW JERSEY

*It has been learned that many eye defects can be corrected by the use of contact lenses, fitted directly over the eyeball. As a substitute for eye glasses they are worn as a safety measure by athletes and sportsmen. Stage folk, motion picture actors, and others who appear before the public are using them increasingly.*

*Here is a discussion of this important advance in optometry. The experienced writer stresses the fact that there is no discomfort or pain involved in their prescription, fitting or use.*

The first concept of contact lenses dates back to 1827, nearly a century and a quarter ago. Their development from the experimental stage of 1827 to their practical application for general public use in 1951 occurred in several distinct stages. At the beginning, only one specific person was involved; today, thousands of people wear them.

What are contact lenses? They are eyeglasses designed to correct refractive errors, that are worn under the eyelids directly over the eyeballs. The original contact lenses were made of glass. During the last decade, plastic (methylmethacrylate) has replaced the glass.

Herschel, a British astronomer, is credited with conceiving the idea. As a research scientist, he suggested this therapeutic measure to his ophthalmologist for the treatment of a patient who had a lacerated cornea. He believed that if a thin glass were placed under the lids, over the eyes, and conforming to the shape of the eye, the problem would be solved. Thus contact lenses were born.

In 1888, Fick studied the possibilities of these devices. Later, the German scientist Mueller made extensive investigations and developed techniques for fitting the glass lenses to the eyes. The Zeiss laboratories began to manufacture contact lenses on a commercial basis, and in 1920 were ready for public service. In 1929, Heine affiliated with the Zeiss laboratories for contact lens research. Since then, we in the United States have taken up the work and have developed contact lenses far beyond our expectations. During this time, Dallos, a Hungarian ophthalmologist, developed a procedure for taking molds of the eyes which is the basis of our present simplified system of fitting. Feinbloom, Obrig, Neill, and the writer, have been cited for the many improvements made in this country during the past two decades. Bear, in England, recently has contributed to the advance. Butterfield, Green and Tuohy on the West Coast have experimented with corneal contact lenses. Each has added various technical im-

provements, with the result that, today, the use of these lenses is safe. In some kinds of work they have become a necessity.

The average person is under the impression that the entire eyeball is sensitive. This is not true. The fore part of the eyeball (cornea), which is directly in front of the colored part of the eye, is very sensitive; but the white section (sclera) is not sensitive. The white is similar in response to the skin of the hand. Contact lenses are constructed so that they fit snugly over the white section of the eye but do not touch the sensitive cornea. That explains why there is no pain associated with the prescribing, fitting, or wearing of such lenses. Since the lenses fit over the eyeballs, they move with the eyes in every direction.

The time contact lenses can be worn varies with individuals. Some persons can use them as long as 14 to 16 hours a day, while others cannot stand more than two hours. These lenses should be considered supplementary to one's regular spectacles. A person should wear his regular glasses for general purposes, and contact lenses only for the particular situation for which they were originally desired, and for which they were prescribed. Some of their special uses will be mentioned later in this article.

Any air space between the corneal section of the lens and the cornea cannot be tolerated. Air pressure, lack of lubrication, and the absence of certain physiologic reactions make it necessary to replace the air with a buffered solution. The older type of lenses, which we were fitting as late as a few months ago, required behind them an artificial buffer solution. We had to change the type of solution for various conditions since the pH of the solution was definitely a controlling factor in determining how long a lens could be worn. Matching the tears was at one time practiced in order to obtain the proper pH and isotonicity. This did not prove to be satisfactory. We are concerned not so much with the pH of the solution at the time the lenses are inserted, but rather at about two hours after insertion. Due to changes in the buffer solution after several hours, its pH no longer remained the same as at the time of insertion. The osmotic pressure had changed, and so had the index of refraction, resulting in gradual blurring of vision. This is the chief factor that controlled the wearing time of these older lenses.

During recent years, a kind of lens was made available that did not require the use of an artificial solution. This type was tried originally about 50 years ago. I used it more recently in an attempt to eliminate anesthetics while taking impressions. This lens is a tiny optical plastic disk of the diameter of the cornea, that is fitted over the sensitive corneal section alone. Ex-

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# Lyophilized Blood Plasma

• By Christopher Roos

SENIOR BACTERIOLOGIST OF BIOLOGICAL PRODUCTION, SHARP & DOHME, INCORPORATED,  
PHILADELPHIA, PENNSYLVANIA

*The providing of whole blood to patients in an emergency is a complicated and difficult task since blood is a highly sensitive substance.*

*"Lyovac" normal human plasma makes an excellent substitute since it obviates the difficulties of instability, matching, storing, and shipping.*

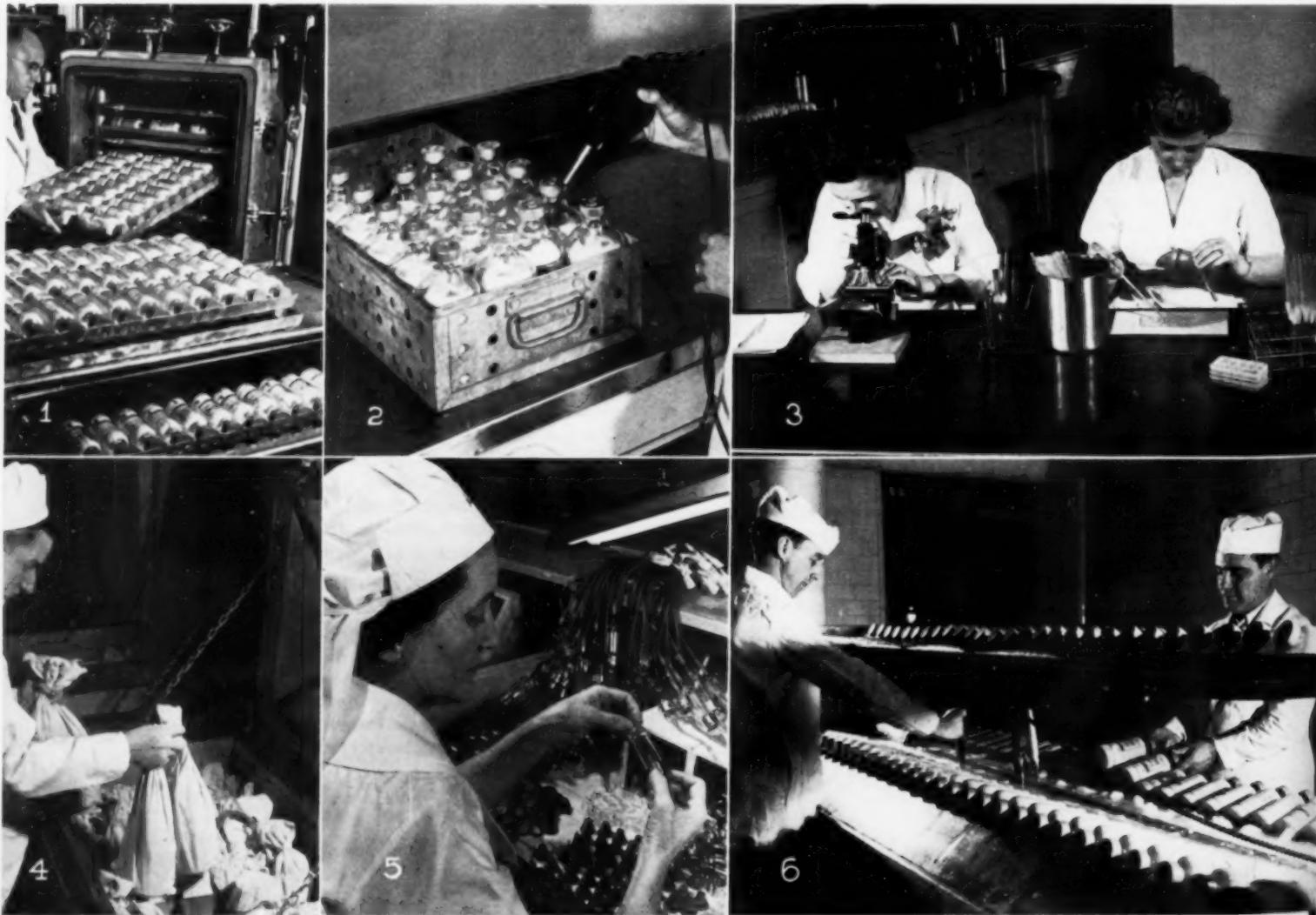
*Here is a brief picture story telling how this "liquid lifesaver" is prepared.*

a ready supply of whole blood for accidents, disasters or armed conflicts presents many difficulties.

Whole blood is a highly sensitive and delicate substance. It is composed of living, breathing cells which have been removed from their natural habitat. Only under ideal conditions can it retain this life. It must be stored in special containers at carefully controlled temperatures; it must be handled carefully; it must be administered shortly after collection and extreme caution must be exerted at all times as it is a perfect breeding place for bacteria.

Further, there are in the blood, substances called agglutinins which cannot be seen, much less determined, under the most powerful microscope. When these agglutinins are "mis-matched" they "curdle," creating a severe reaction in the patient.

To prevent this complication, a series of tests must be performed and only special types of blood may be administered to certain patients. A complete supply of whole blood requires eight distinct blood types.



Nineteen years ago, Sharp & Dohme, Incorporated, Philadelphia drug firm, instituted an extensive research program to find a substitute for whole blood, a substitute that would meet medical requirements while elimi-

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LEGENDS FOR PICTURES

(Not arranged in sequence of work)

- 1 — FROZEN PLASMA being taken out of a lyophile chamber after dehydration. The "shell" formation of the plasma affords a large surface against which the vacuum may operate and thus accelerate the dehydration. Lyophilization, the process of dehydrating frozen materials under vacuum, was developed through Sharp & Dohme research.
- 2 — VACUUM SEALED BOTTLES of irradiated, dried plasma are checked with a high-frequency spark tester which produces a purple glow in properly sealed bottles. Although the finished packages carry an expiration date of 5 years, no significant change was found in plasma which had been stored at room temperature for 8 years. "Lyovac" Normal Human Plasma Irradiated, therefore, affords a readily available, stable source of plasma for use in emergencies.
- 3 — FRESH, CITRATED HUMAN BLOOD is subjected to serological tests and each unit must show confirmed negative results.
- 4 — WHOLE BLOOD arrives at Sharp & Dohme's Glenolden, Pa., plant from a donor center. Each bottle is protected by a canvas bag and shipped in a refrigerated box. Bottles are being removed from box in which temperature is maintained at between 40 and 50 degrees Fahrenheit.
- 5 — INTRAVENOUS FLOW OF PLASMA is accomplished and carefully regulated by the filter flow control being assembled here. Equipment for intravenous injection consists of connecting needle, rubber tubing, filter, flow control, glass needle adapter and intravenous needle, sterilized and ready for use. This equipment may be used repeatedly and each package carries three sets of replacement parts to lengthen service.
- 6 — "SHELLING" MACHINE rotating bottles of irradiated plasma in an alcohol-dry ice bath at a temperature of about -70 degrees centigrade. The plasma is frozen on the walls of the bottle to form a solid "shell" with a hollow core. The freezing is done immediately following irradiation to assure minimal decrease in complement and prothrombin.
- 7 — BACTERIAL STERILITY of the plasma is checked at various stages of production. In a special "sealed" room, these technicians are preparing to inoculate nutrient agar slants and bouillon bottles with restored "Lyovac" Plasma. The bottles and slants will disclose any aerobic or anaerobic organisms.
- 8 — LABORATORY TECHNICIAN loads a centrifuge machine which rotates bottles at a speed of approximately 1800 r.p.m. for one hour to separate the plasma from the blood cells.
- 9 — DRAWING OFF PLASMA from centrifuged whole blood. The plasma is the liquid in the upper part of the bottle and constitutes 50% of the total volume of blood. Plasma from approximately 50 donors is drawn off into the large glass container at right. Aseptic conditions prevail throughout. Floors and benches are scrubbed with disinfectant solution after each operation, and the walls are lined with ultraviolet germicidal lamps. In rooms where air is circulated it is first passed through a series of filters and germicidal lamps.
- 10 — MICE ARE INOCULATED with plasma in one of the 16 tests to ascertain any toxic properties. If mice don't get sick from plasma it is unlikely that the patient will.
- 11 — POOLED PLASMA is irradiated in this special, stainless steel apparatus originally designed by Sharp & Dohme. A constantly rotating drum picks up a thin film of plasma on its curved surface. As the drum turns, the film of plasma is irradiated by a battery of ultraviolet lamps. The plasma is then removed by a flexible wiping blade, and conveyed to a sterile container. Groupleader, wearing a plastic mask, checks flow of plasma from pooled plasma container. The lamps are metered each day by a photoelectric cell to check the ultraviolet output. The effectiveness of the irradiation is also checked by other tests at frequent intervals.
- 12 — TEMPERATURES OF RABBITS are automatically recorded during the pyrogen test of sterile, distilled water. "Lyovac" Normal Human Plasma Irradiated is supplied in a package with a bottle of pyrogen-free diluent.



nating the matching, storage, shipping and instability problems of whole blood.

As a result of its research activities, the Company provided the medical profession with "Lyovac" Normal

Page 34)

## Contact Lenses

(Continued from Page 17)

periments with this corneal lens led to the next important development.

The newest lens is a full size lens with all the advantages of the type just described which fits over only the front section of the eyeball, yet it requires no artificial buffer solution. Instead, the naturally flowing tears enter and circulate in the corneal section of the lens. Elimination of the buffer solution, however, creates other new interferences, but these are so much less troublesome that we regard the new fluid-less lens as a great boon.

The procedure for fitting contact lenses depends upon the doctor's technique, the eye requirement, and the patient's psychological reaction. There are two basic systems. In one, various lenses of different shapes are placed over the eyes, and the trial lens conforming most nearly to the shape of the sclera is duplicated for the patient. The second method requires greater skill on the part of the practitioner since he takes an impression directly from the eyes just as a dentist takes an impression over the gums to enable him to fit accurately a bridge or denture. In my opinion, contact lenses made from accurate impressions involve less guess work. Under an expert's technique there is no discomfort in taking the impression. Pain is definitely out of the question.

Corneal contact lenses are fitted from a trial set. The radii of curvature of the cornea are noted by instrumentation (keratometer) and the appropriate trial lenses are calculated on that basis. The patient's wearing ability is pre-determined during this period, except that the time element is not constant, nor does it remain the same over a long period of time. These lenses require no artificial solution, but most patients cannot wear them very long because the lenses rest on the cornea and create discomfort or irritation.

These corneal contact lenses taught us that the elimination of the artificial buffer solution is desirable. Further research in combining the mechanical properties of corneal lenses and those of the previously fitted full size lenses, created the now popular fluid-less contact lens. The lens is not actually fluid-less insofar as the total absence of liquid is concerned. We insert the lens over the eye, and within a few minutes the corneal section is filled with natural tears. This is much better than any artificial solution could be. Moreover, there is a continuous replacement of tears since there is some flow in and out. This lens can be used for any purpose, while corneal lenses have limitations because of their size.

Contact lenses are valuable in the treatment of eye conditions that regular spectacles cannot correct, such as keratoconus (cone-shaped, irregular cornea), corneal scars, ulcerations, high astigmatism, high errors of refraction, binocular imbalances, differences between the sizes of the two ocular images, fusional disturbances, etc. They are used for occupational purposes, by

radio and stage performers who appear before an audience, by public speakers, and others. As a safety measure in other occupations they are most valuable. For sports, including swimming and all forms of ball playing, they are used extensively.

If one eye is disfigured, a contact lens can be placed over it, with an artificial iris in it made to match the appearance of the other eye. After eye surgery in cases of monocular or binocular cataract, these lenses afford greater visual comfort to the patient than do spectacles, even if the time factor may be limited. The psychological effect on persons who cannot see without glasses yet who do not like to wear them socially or for specific functions or purposes, is most favorable.

Contact lenses have to be prescribed and fitted. The visual and eye correction is prescribed by the optometrist or ophthalmologist. The fitting of the shape of the lens can be done by these eye practitioners or, in many states, under the supervision of these men by contact lens technicians. Recently, the Contact Lens Section of the American Academy of Optometry adopted rigid rules for certifying optometrists who are Fellows of the Academy and who meet the requirements of this Section. To date, only a few Fellows have been so certified.

We emphasize again that there is no discomfort or pain involved at any time during the prescribing, fitting or wearing of contact lenses. Formerly, mild topical anesthetics (2% Butyn) were used by patients until they became used to wearing the lenses. We discovered, however, that it was only fear that necessitated the anesthesia. Likewise, when Dallos began to take eye impressions, he advocated the use of local anesthetics, and for a long time for this one step one-half per cent Pontacaine was employed under medical supervision. The writer is responsible for developing the first technique of taking impressions without medication, and this modified procedure is now everywhere the accepted method. It causes the least discomfort to the patient. If the patient believes what he is told, there is no problem, for actually no pain is caused by the present method.

The specialized study of contact lenses is included in the curriculum of most colleges of optometry only to the extent of giving the student some highlights and some basic information. Before he engages in practice, the practitioner should take post-graduate courses which cover the subject theoretically and clinically. Some schools offer such graduate instruction. Advanced instruction is also available from practicing specialists, and from research institutions and laboratories and foundations.

There are very few persons who cannot wear contact lenses, but those who can (and they should constitute the majority) should use them on schedule. Some persons, but not many, can wear them the entire day. We suggest, therefore, that before one gets his contact lenses he should be told that he may anticipate using them only part of the day for the desired purpose. He will use his regular spectacles the rest of the time. ●

## Toxicology in Medico-Legal Problems

• By Sidney Kaye, F.A.I.C., M.Sc., (New York University)

TOXICOLOGIST, CHIEF MEDICAL EXAMINER'S OFFICE, COMMONWEALTH OF VIRGINIA,  
RICHMOND, VIRGINIA

*Since pathological examination cannot precisely identify poisons that may have caused death, or determine their amounts, the toxicologist plays an extremely important and sometimes dramatic role in discovering the cause of violent deaths.*

*His findings are so important he cannot afford to err. He must be certain of his results. His work must be quantitative as well as qualitative.*

*This story shows the importance of the toxicologist's work, the procedures he uses, and some of the precautions he takes.*



It is agreed generally that in areas where adequate toxicological facilities are provided, approximately ten per cent of all deaths investigated by medical examiners or coroners are likely to be the result of poisoning. In a considerable number of violent deaths, poison may be found to be a contributing cause of death.

Since the changes produced by poisons on various body tissues either are primarily biochemical rather than anatomical, or are of such character that the causative agent cannot be identified precisely by pathological examination, it becomes the responsibility of the toxicologist to produce quantitative proof that a specific chemical agent has caused or contributed to death. In clinical medicine where therapeutic agents may exhibit deleterious or fatal effects, the demand upon the toxicologist is less exacting, but in medico-legal investigations it is essential in many deaths that chemical agents be identified specifically and quantitatively determined, or be completely excluded. Several case reports from personal files cited will serve to demonstrate this need.

1. A young husband returned home unexpectedly one week-end to find that his wife had been unfaithful. This was not the first offense and he informed her of his intention to leave, and sue for divorce. The wife persuaded him to remain with her for one last evening and celebration. Together they made the round of several taverns. The husband died shortly after they returned home. Since this was a sudden death without medical attention, the medical examiner was called by the police. An autopsy and toxicological analyses were performed. There was found a moderately high concentration of alcohol in the brain and body fluids but not an amount sufficient to account for death. Autopsy did not disclose any anatomical cause. Further analyses showed large amounts of chloral hydrate in lethal quantities. Upon interrogation, and confronted with this evidence, the wife later confessed to poisoning her husband when he did not succumb to her wiles and pleading not to leave her.

2. A young chemist was found dead at his laboratory one morning after working late the previous evening. A slight pink discolored skin pointed to the possibility of poisoning with illuminating gas (carbon monoxide). Analysis proved the absence of carbon monoxide. Further analysis revealed large amounts of cyanide. Distribution studies were made which revealed massive amounts in the stomach in the form of sodium cyanide and the usual lethal amounts in the brain, liver, kidney and lungs. If ever the question be raised at a later date regarding whether this was an accidental death due to inadvertent breathing of prussic acid (hydrocyanide gas), these analyses would preclude any doubt of miscarriage of justice.

3. A young man "hitched" a ride on a large trailer truck on the highway late one night. The night was cold and the windows were closed. The hitch hiker was sleepy after so long a wait for a lift. The driver suggested that he go to sleep in the small compartment behind the cab used for this purpose. He agreed to awaken the young man in the morning.

The next morning when the driver stopped for breakfast, he found his rider cold and dead. He notified the police, who in turn notified the medical examiner. The body was removed to the morgue for investigation to determine the cause and nature of death. In the interim the truck moved on southward. Analyses showed large amounts of carbon monoxide (in lethal quantities). This information was phoned to the headquarters of the State Police, who in turn radioed to head off the truck and driver. On close inspection, the truck was found to have a faulty exhaust which allowed carbon monoxide (exhaust fumes) to leak into the truck.

4. A man was admitted to the hospital with severe injuries caused by an automobile accident. His condition required a number of blood transfusions. Death occurred several days later. An autopsy and several routine analyses were performed in a general manner. The kidneys showed a faint trace of mercury. Because of the circumstances and the extent of his injuries (which no doubt caused his death), the analysis was repeated, with the same results. The quantity of mercury found was insufficient to account for death, but its presence was baffling. A thorough investigation of all treatment received at the hospital prior to death revealed that the decedent had received four transfusions of plasma that contained merthiolate (sodium ethyl mercuri-thio salicylate) as a preservative, which was the practice during a portion of the last war. This explained the presence in the kidneys, of mercury, which in no way was associated with his death.

5. A man was observed staggering down the street one Saturday night. The Police stopped him for questioning but received incoherent answers. However, dur-

*(Continued on Page 28)*

# Modern Breadmaking

• By **William H. Catheart, Ph.D.**, (New York University)

THE GREAT ATLANTIC AND PACIFIC TEA CO., NATIONAL BAKERY DIVISION, NEW YORK, NEW YORK

*If you believe that the baking of bread on a commercial scale is as simple as the home process, here is proof to the contrary.*

*In recent years baking technology has been continually improved through the wide application of basic science information and theories. Despite much progress a number of problems still await solution.*

*Seldom will you find in such a brief article so much valuable and interesting information about the staff of life. Your science students will enjoy it.*

For a century baking has been changing from an art to a science as a result of the efforts of chemists, other scientists, and engineers. Increased scientific knowledge has made possible the improvement of the functional values of baking ingredients, and the invention of specialized machinery has resulted in the large scale production of baked products of uniform quality.

Today, strict specifications for various chemical and physico-chemical factors of baking ingredients can be followed. The changes occurring during the mixing, fermentation, and baking of doughs are complex, however, and the experience of the skilled artisan is still needed to some degree. As might be expected, manufacturers of ingredients were employing scientific knowledge to improve their products before the baking industry applied scientific methods to its problems. Today, the baking industry is a contributor to the scientific literature, and through the medium of the American Association of Cereal Chemists and their journal, *Cereal Chemistry*, scientific papers relating to the problems of the milling, baking, and brewing industries are published.

Modern white bread is made from flour, water, yeast, and salt, with liberal amounts of nonfat dry milk solids, sugar, and shortening added. Small

quantities of mineral salts to feed the yeast and condition the dough, and vitamin enrichment tablets are also added. It is made in large, modern bakeries equipped with automatic machinery, where the bread is untouched by human hands from the time it leaves the dough mixer until the package is opened by the consumer.

There are two methods of mixing and processing dough. That most widely used commercially is known as the sponge and dough method; the other, the straight dough method. In the sponge and dough method approximately 60 per cent of the total flour is mixed with the yeast, yeast food, and sufficient water to form a firm dough mass, known as the sponge. The sponge is then fermented for approximately five hours at 80° to 82°F. After fermentation, the sponge is returned to the mixer, the balance of the flour and water and the other bread ingredients are added, and all are mixed into a smooth dough. This second phase is known as the dough stage. After approximately 15 minutes additional fermentation the dough is processed into bread.

In the straight dough method, all the bread ingredients are mixed together at one time into a dough which is fermented for approximately three hours at 80° to 82°F.

In both methods sufficient humidity is maintained during fermentation to prevent the formation of a crust on the exposed surface of the dough. The same machinery is used to process bread whether the sponge and dough, or the straight dough method is used. After fermentation, the dough, weighing more than 1000 pounds, is put into a machine known as a divider which cuts out pieces of dough, each the correct weight to yield a loaf of bread. From the divider the dough piece goes to the rounder which forms it into a dough ball having an unbroken outer surface or "skin." Then to another device, the overhead proofer, where the dough piece ferments for approximately 15 minutes before going to the moulder which shapes it into baking pan size.

After the dough piece is

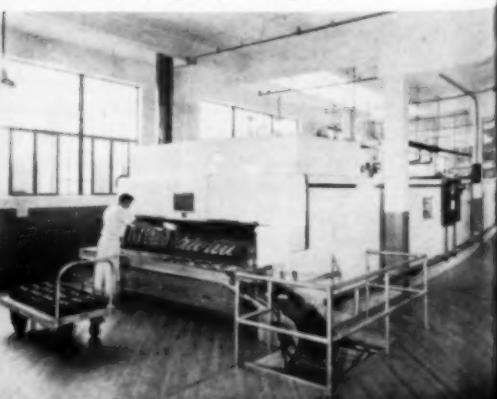
DOUGH MIXERS—Flour is automatically weighed into hopper above mixer.



BREAD SLICING AND WRAPPING MACHINES.



MODERN GAS FIRED TRAVELING OVEN—Bread delivery end in foreground.



panned, it is again fermented for approximately one hour in a heated cabinet known as a proof box, maintained at 95° to 100°F., and 80 to 85 per cent relative humidity. In the proof box the dough piece doubles in volume. It is then placed in the oven where it is baked at 425° to 475°F. for approximately 35 minutes. After baking, the bread is removed from the baking pan and cooled to an interior temperature of 85° to 90°F. After cooling, the bread is sliced and wrapped by machine.

#### Improvements in Ingredients

**Flour**—Wheat is unique among the cereal grains because only wheat flour, when mixed with water into a dough, forms a proteinous, rubbery mass called gluten. Gluten forms an elastic network throughout the dough mass which retains the carbon dioxide produced during fermentation, thus causing the dough to expand. Because of this property, only flour milled from wheat yields light, porous bread. In the U. S. Government Standards of Identity for Flour, the word "flour," unqualified, means wheat flour. Since earliest times flour millers have endeavored to satisfy public demand and to produce the lightest colored flour possible with the machinery available. When the steel roller flour mill was invented, it supplanted the buhr-stone mill and enabled the miller to produce a more uniform flour having a minimum of bran specks in it. Since this removed a portion of the vitamins and minerals, today they are being added back to the flour.

Yeast in a fermenting dough produces carbon dioxide, alcohol and other compounds which leaven and give a characteristic flavor to bread. It requires sugars for its functioning. To prevent the yeast from exhausting the sugar added to the dough, it is necessary to have present small amounts of diastatic enzymes which convert starch into simpler carbohydrates. Minute quantities of these enzymes occur naturally in wheat flour, but the level is not constant and if not adjusted, can result in non-uniform bread. Formerly, bakers had poor control of this important flour quality factor, but now the diastatic activity of baker's flours is controlled at the flour mill. A predetermined quantity of malted wheat or malted barley flour is blended with the flour by the miller to insure the correct diastatic activity to meet a particular bakery's need. Recently, diastatic enzymes of fungal origin have been approved for use in bread. The control of diastatic activity has been a worthwhile application of scientific knowledge toward better bread.

**Yeast**—Until approximately 80 years ago, bakers depended upon wild yeasts and bacteria to leaven doughs. The practice was to make a paste of flour or other starchy materials suitable for microbial growth, and set it aside until micro-organisms both in the ingredients and also air-borne, caused fermentation. After fermentation had progressed, the leaven was incorporated with the other dough ingredients. A portion of the dough was reserved and fermented until needed to leaven fresh dough. The procedure was repeated many times before a new leaven was begun. With such practices the production of uniform bread on a commercial scale was impossible.

Soon after Pasteur ascribed fermentation to living yeast plants, certain species of yeast particularly suited to fermenting dough were isolated, and the technology of yeast production was begun. This was a most important step in bringing mass production methods to the baking industry because a compressed yeast of uniform purity became available to bakers and enabled them to ferment doughs on a time schedule. Previously, production had been subject to the vagaries of chance contamination by wild yeasts and bacteria. Now yeast manufacturers are offering to bakers active dry yeast which does not require refrigeration and can be stored for reasonable lengths of time before use.

**Milk**—The technology of condensing and drying milk has advanced steadily and has made available to the baking industry sweetened condensed skim milk and nonfat dry milk solids of uniform baking quality and purity. Fresh milk that has not been especially heat-treated yields bread of poor quality. The reason for this effect is not yet known but several explanations have been advanced. It is therefore necessary that milk solids intended for use in bread shall be heat-treated during processing to insure good baking quality. Advances in engineering brought about the spray drying of skim milk, which resulted in nonfat dry milk solids of improved solubility and color.

**Shortening**—Fats of vegetable and animal origin are used as bread ingredients. Hydrogenated shortening is widely used, but many bakers prefer lard because of its excellent shortening power and distinctive flavor. Butter is used to a limited extent in bread. Advances made in the technology of edible fats and oils are economically important. Chemists have learned how to refine, deodorize, and hydrogenate domestic vegetable oils once considered useless, and to transform them into valuable edible fats. They have found that mono and diglyceride shortenings have better emulsifying properties than the commonly occurring triglyceride shortenings, and that the use of mono and diglyceride shortenings improve the freshness retention properties of baked products.

**Sugar**—Most commercial white breads contain sucrose or dextrose. Sucrose is of cane or beet origin, and dextrose is the crystallized monohydrate obtained from hydrolyzed starch. Sugar is added to dough primarily to impart sweetness to the baked bread, but it also serves during fermentation as a supplementary food supply for the yeast. Sugar levels above 10 per cent of the flour weight inhibit yeast activity and are not ordinarily used in breadmaking. Honey is used in bread to a limited extent, but other sugary materials such as molasses, invert sugar, corn syrup and maple syrup, although used in other bakery products, are not usually ingredients of bread.

**Other Ingredients**—Research reveals that for maximum growth yeast requires certain elements, especially calcium, phosphorus, and a readily available source of nitrogen. Also, that the baking quality of flour improves when minute quantities of an oxidizing agent are added to the dough. This knowledge spurred the development of new dough ingredients called yeast

foods or dough conditioners. These materials usually contain calcium, phosphorus, an ammonium salt, and an oxidizing agent such as potassium bromate or iodate. Yeast foods or dough conditioners not only accelerate yeast growth and improve baking quality, but aid in neutralizing the effect on dough of variations in the hardness of the ingredient water. They also contribute to the nutritive value of bread.

Another instance when scientific research resulted in the development of a new ingredient for bakery products was the discovery that the calcium and sodium salts of propionic acid are effective inhibitors of mold and other microbial infections.

In certain types of bread and rolls, eggs are an ingredient. Frozen whole eggs, egg yolks, and egg whites, comparable with fresh shell eggs in baking quality and flavor, are used. The egg products, separated from the shell under strict sanitary conditions, are quick-frozen and kept frozen until needed by the baker. An inconvenience to users of frozen egg products has been the length of time required for defrosting. Recently it has been demonstrated that frozen eggs and other foods can be defrosted rapidly without injury to the thawed food, by means of radio-frequency heat.

#### Enrichment of Bread

During the milling of flour, a portion of the vitamins and minerals contained in the wheat berry are removed. They are, therefore, lacking in the finished flour. Since 1916, the work of different investigators has shown that the vitamins found in wheat are important factors in the maintenance of good health. For some time, only concentrates of these vitamins, which were of the B complex and extracted from natural materials, were available. These vitamin extracts were too costly to add to a staple, low cost, food such as bread. After thiamine (Vitamin B<sub>1</sub>) and riboflavin (Vitamin B<sub>2</sub>) had been synthesized commercially, it became feasible to restore white flour to whole wheat levels of thiamine, riboflavin, niacin (another B vitamin) and assimilable iron.

The program of enrichment of white bread and flour by the baking and milling industries was undertaken voluntarily, and it was not until 1943, during the war, that the Government made the enrichment of white bread mandatory. Since the end of World War II the U. S. Government has not compelled bakers to enrich white bread, but it does require that bread labeled "enriched" and shipped in interstate commerce must meet the requirements listed in Table I. Twenty-four different states now have laws requiring the enrichment of white bread and all require substantially the same enrichment levels as the U. S. Government standards.

TABLE I

		Minimum	Maximum
		Milligrams Per Pound	
Thiamine	(Vit. B <sub>1</sub> )	1.1	1.8
Riboflavin	(Vit. B <sub>2</sub> )	0.7	1.6
Niacin		10.0	15.0
Iron		8.0	12.5

Bakers employ either of two methods to enrich bread. Most bakers add to the dough a sufficient number of enrichment tablets containing thiamin, riboflavin, niacin and iron, to bring the baked bread up to the required enrichment level. Others use enriched flour to which the miller has added the necessary enrichment factors. Both methods of enrichment are permitted by the proposed Standards of Identity for Bread<sup>1</sup>. Early in the enrichment program a special high vitamin yeast was used but today it has been discarded in favor of enrichment tablets.

Scientific evidence indicates that the enrichment of white bread has been a worthwhile contribution to the health of the American people.

#### Staling of Bread

One of the more puzzling problems of the baking industry is the staling of baked products. The popular conception of staling is that it occurs when bread loses moisture and dries out. Though loss of moisture is a factor in staling, the phenomenon is more complex than this. As early as 1852, Boussingault, a French investigator, demonstrated that bread staled even when stored in a sealed container. He also showed that stale bread, at or near its original moisture content, could be refreshed by heating to 60°C. (140°F.).

There are changes in bread that can be observed as it stales; the crust which was crispy immediately after baking becomes soft and leathery, and the crumb which was soft and velvety when fresh becomes firm and harsh to the touch. Various factors such as the swelling of the crumb in water, the amount of soluble starch, crumbliness of the crumb, and compressibility of the crumb, change measurably during staling and all have been used as bases for tests designed to follow the progress of staling. Softness of bread is closely linked to freshness. Most of us are familiar with the consumer's habit of squeezing a loaf of bread to judge its freshness. Because of this, compressibility measurements are particularly useful in following the progress of staling, for as bread ages the crumb becomes increasingly firm and less compressible. Various instruments have been devised to measure the compressibility of bread crumb.

The body of knowledge of starch chemistry indicates that changes in the composition of starch after baking may account for the increasing firmness of staling bread crumb. Scientists have demonstrated that bread can be kept soft indefinitely with either heat or cold. When bread is held at 60°C. (140°F.) or higher it will remain soft indefinitely if no moisture is lost. However, it is impracticable to store bread at such a temperature because undesirable flavors will develop after 12 to 24 hours of storage. Freezing storage will keep bread fresh for long periods of time. It has been shown that bread frozen and stored at -35°C. (-31°F.) will remain fresh for approximately one year. When

(Continued on Page 33)

<sup>1</sup> The Federal Security Agency has proposed Standards of Identity for a number of breads including white bread. (Federal Register Vol. 15, No. 152, August 8, 1950).

# NEW BOOKS



THE BOOK SAYS --

## The Physician Examines the Bible

• By C. RAIMER SMITH, B.S., M.D., D.N.B.  
New York: Philosophical Library. 1950.  
Pp. vii + 394. \$4.25.

In this extraordinary book a practicing physician whose hobby is the study of the Bible, sets out to prove that the Bible is not out of date scientifically or medically. Many hundreds of quotations show the author's familiarity with the Bible. He includes short monographs on science and medicine. For some reason not quite clear he quotes from Milton, Browning, Tennyson and other poets. The tone of the book may be judged from the following:

"Therefore we will proceed to strip Mr. Bible down to bare facts and give him a complete physical and mental examination." (p. 4)

"As the idea of natural causes of disease became better established the physician began to treat the sick instead of the priests." (p. 12)

"Atoms, molecules, electrons were pure theories until the advent of the atomic bomb." (p. 188)

"It disgusts me to hear a one-horse preacher get up and give a sermon against evolution when he does not even know what evolution means." (p. 197)

This book is not recommended for the school library. Its readers should be persons of mature judgment who have a good background in science and religion, and perhaps some knowledge of medicine. *H. C. M.*

## Methods and Materials for Teaching General Physical Science

• By JOHN S. RICHARDSON and G. P. CAHOON.  
New York: McGraw-Hill Book Co., Inc.  
1951. Pp. viii + 485. \$4.50.

This book is pretty nearly a "must." Seldom do we find within two covers so much sound sense about science teaching and so much helpful material and careful direction. Prospective teachers, science teachers in service in elementary and secondary schools, and even those in the early years of college will find this book not only stimulating, but of very practical help.

Part I, entitled "Laboratory Experiences for Science Teaching" will be especially useful to the beginning teacher and to the teacher who has had to scrimp. It discusses the individual-laboratory vs. demonstration question, student projects and reports, field trips, maintaining equipment, and making use of basic operations and devices. The chapters on visual and auditory materials and on "Teaching for thinking through laboratory experiences," are especially good.

Part II is devoted to demonstrations, laboratory experiences, and projects in general science, physics and chemistry. These are well selected, carefully described, and workable. Some are familiar, some new. The enterprising teacher will find here much to help him give interest and variety to his classroom and laboratory procedures.

*H. C. M.*

## Sourcebook on Atomic Energy

• By SAMUEL GLASSTONE. New York: D. Van Nostrand Co., Inc. 1950. Pp. 546. \$2.90.

This comprehensive and timely book is a valuable contribution to the literature. Be sure to add it to your library. In it you will find all the important basic facts as well as the newest information about atomic energy,—all that can be revealed without jeopardizing national security. Published under the sponsorship of the United States Atomic Energy Commission, and written by a distinguished educator and scientist, its technical accuracy was further assured the scrutiny of Compton, Seaborg, Aebersold, and a score of other workers in the field.

The author uses a clear, direct style but the book will not be easy reading for the layman. Much of it may be beyond his comprehension. But every teacher of physical science will do himself a good turn by purchasing this book and studying it assiduously.

Starting with a brief view of atomic theory the book moves swiftly into a consideration of atomic structure, radioactivity, isotopes, nuclear fission and transmutation, the utilization of nuclear energy, the transuranium elements, and cosmic rays and mesons. The biological effects of radiation, units and dosages, monitoring and protection, and waste disposal receive attention.

*H. C. M.*

## The Analytical Balance

• By WILLIAM MARSHALL MAC NEVIN. Sandusky, Ohio: Handbook Publisher's, Inc. 1951. Pp. xiii + 60. \$1.50.

This helpful little book discusses the construction of an analytical balance, and instructs how to mount, clean, test and use a balance. There are directions for calibrating, adjusting and caring for weights. The point is stressed that while the one who uses it should know all about the balance, only a specialist should be permitted to undertake major repairs. There is a useful list, with addresses, of balance manufacturers and repair specialists.

*H. C. M.*

### The Chemical Formulary, Volume IX

• By H. BENNETT, Editor-in-Chief. Brooklyn, New York. Chemical Publishing Co., Inc. 1951. Pp. xvi + 648. \$7.00

In its general organization, Volume IX follows the plan established by the preceding volumes of this series. Volume VIII was favorably reviewed in *The Science Counselor* for September, 1948. The 1951 addition to the series is worthy of like commendation. There are chapters devoted to cosmetics, foods, insecticides, lubricants, paints, photography, soaps, and a dozen other groups.

All the thousands of formulas presented are new in the sense that they did not appear in earlier volumes. Each is intended to represent the best and most modern thought in its field. From a close inspection of the sections with which the reviewer is most familiar, it is apparent that the Editor has chosen formulas which make use of the latest materials, and that the formulas are workable. Since the formulas are designed for commercial as well as for small scale and experimental purposes, the inclusion of lists of chemical and trademarked products and the firms from which they may be obtained is an especially commendable feature

H. C. M.

### The Atom at Work

• By JACOB SACKS, Ph.D., M.D. New York: The Ronald Press. 1951. Pp. xii + 327. \$4.00.

Here at last is a good book on atomic energy written not for the specialist, but for the layman who may have little or no science background. It is a well-illustrated, non-technical, non-mathematical treatment of a complex and expanding subject, written by a competent scientist who knows how to hold the reader's interest. As a good writer should, he starts at the beginning. A discussion of the structure of matter leads into a consideration of radioactivity. Then follows a study of the atomic nucleus and of isotopes. Although Dr. Sacks discusses atomic warfare past and future, his major interest lies in the peacetime uses of atomic energy in chemistry, biology, agriculture, medicine, and business. This book will be useful in science survey courses, and as supplementary reading for science students in high school and college.

H. C. M.



### Physics in Humor

(Continued from Page 7)

So far, the physics has actually been present in the material. In Figure 8, also from Superman, there appears to be none. However, the frames not shown indicate that Superman is traveling on an urgent errand; therefore presumably near his top speed. Let us analyze the frame in the light of Doppler's principle. When source and hearer are moving apart, the apparent frequencies of the sounds emitted are all lowered, with the change greater for higher speeds. Offhand, we should be able to find the speed at which "speech sounds"—say up to 2,000 vibrations per second—would all be reduced below the lower limit of the ear, about 40 vps. This does not do Superman justice; without doubt he can still handle a "conversation" in which all frequencies are below 40. His hearer would be helpless, unless Superman anticipates the difficulty by "speaking" originally at ultrasonic frequencies, which would then be reduced, by the Doppler effect, to the range of the

human ear. In this way the possible highest speed attainable by Superman could be raised, but not indefinitely. The equation for this situation contains the term  $w - v$  in the denominator, where  $w$  is the speed of sound waves. If Superman's speed  $v$  were to equal or exceed that of sound, not even super powers could allow a conversation to occur, especially a two-way conversation. Thus, whatever other evidence may exist, Superman's speed is not as high as that of some modern planes.

Naturally, some topics in physics are illustrated very often, others seldom, and many not at all. Probably the topics shown are those best known by the artists, and supposed to be best known to the readers. Many parts of mechanics are illustrated, and several topics in sound and heat. In electricity, after magnetism, electrostatics, and very simple circuits, there is almost nothing. I have seen nothing to illustrate either a motor or a dynamo principle, nor anything which really distinguishes between AC and DC. In optics, the parts dealing with mirrors and lenses are well illustrated. Wave theory naturally is not, but it is surprising how little can be found about color, even in the weekend editions when the strips are printed in color.

Figure 9 is a famous cartoon, without which no collection is complete. In view of the molecular nature of matter, this should be a theoretically possible happening, although highly improbable. In effect it is a modified and speeded up version of the classic experiment in which gold molecules diffused (over a period of years) into a solid lead block. In Fig. 9 of course, the molecules are supposed to move as a group, rather than to diffuse.

Making a collection of cartoons which illustrate physics is a very pleasant hobby. One more fact should be noted; if you let your friends see the collection after it has taken shape, you will get contributions from them, often from sources which you would not normally see.

The principal use of such material in teaching is as introductory material, to stimulate interest. College students respond to these items (even the rather serious and intellectual group of students with whom I am connected). I have no direct experience on the secondary level, but it would seem probable that high school students would be even more responsive. ●



### Fisher Scientific Co. Expands

Over an acre of modern shelving and some 4,400 feet of fluorescent lighting are to be found in the new plant of the Fisher Scientific Company recently opened in Washington, D. C. The new supply house will serve as a stocking, shipping and repair center for the Atlantic Seaboard area.

The Fisher Company is the largest manufacturer and distributor of scientific instruments and apparatus in the United States and Canada. It has been called a "technical Sears-Roebuck" since it sells largely through catalogs and fills its orders through the mail.



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## Toxicology

(Continued from Page 21)

ing the conversation, he "passed out." This "obviously" was the usual drunk that ought to sleep it off in jail, therefore the "Black Maria" brought him to the local jail. When they came to awaken him the next morning, he was dead. An autopsy showed that he had not been drunk, (no evidence of any drinking at all) but that he had a fractured skull (accidental fall) which produced similar symptoms.

A test for alcohol of his blood at the jail would perhaps have saved his life by instituting proper treatment.

### Toxicological Analysis

THE actual testing for poisons presents no great difficulty for the expert if the poison is present in moderate amounts, but considerable skill and experience are required in separating poisons from extraneous materials and in purification before specific tests can be applied.

It is impractical to describe here the various separation methods employed to isolate poisons since they vary with the nature of the materials. For most practical purposes the general scheme and modifications of Stas-Otto is still used for the isolation of many of the common poisons; for speed and conservation of material, some of the common poisons are divided into several groups, and the isolation is performed serially.

1. **Volatile:** Alcohols, acetone, aldehydes, camphor, aniline, benzene, nitrobenzene, phosphorus, ether, chloroform, cyanides, carbon disulfide, phenols, pyridine, chloral etc.
2. **Acid ether soluble:** Barbiturate derivatives, salicylates and derivatives, benzoic acid, caffeine, cantharides, acetanilide, phenacetin, picROTOXIN, sulfonal group, etc.
3. **Alkaline ether soluble:** Alkaloids in general such as atropine, cocaine, codeine, quinine, brucine, strychnine, aconitine, etc.
4. **Ammonia ether, chloroform (ethyl acetate) soluble:** Morphine, theobromine, apomorphine, etc.
5. **Heavy metals:** Lead, bismuth, cadmium, antimony, arsenic, mercury, thallium, zinc, etc.

Testing for these five main groups is usually adequate for the isolation of many of the common poisons. However, it must be remembered that even some of these require special treatment (aniline, phosphorus, ether, chloroform, cyanides, methyl bromide, etc.), or they may be missed.

Still many others such as fluorides, carbon monoxide, radio-active agents, fluoroacetate, toxalbumins, metrazol, D.D.T., glucosides, benzedrine, etc., are analyzed by particular methods and techniques. A final word of caution: Toxicological examination of biological material is work for an expert and should never be undertaken except by those having specific training and experience. The rough qualitative testing sometimes attempted by those without instruction or experience in forensic chemistry is injudicious since it wastes irreplaceable material and may lead to an erroneous result.

Where poison is suspected of having caused or contributed to death, the demand on the part of integrated medicolegal investigation for scientific chemical proof can be met best by providing the toxicologist as soon as possible with full information and adequate amounts of the proper material suitably collected and preserved.

### Preservation and Shipment of Specimens

IT IS essential that the toxicologist be supplied with an adequate amount of material placed in chemically clean, glass covered containers. All specimen jars should be sealed in a distinctive manner so that any tampering with the material will be evident immediately. Specimens should be locked in a refrigerator until shipped or otherwise delivered to the toxicologist. The continuity of possession must not be broken. If continuity of possession cannot be shown, the material becomes valueless for medicolegal purposes. A receipt with the date and hour indicated should accompany all transfers.

### Material Best Suited for Toxicological Analysis

Specimen	Minimum Amount	Poison for Which Best Suited
Urine	All available	In nearly all types of poisoning.
Stomach Contents	All available	In which poison is known or thought to have been taken by mouth within a few hours.
Intestinal Contents	All available	For cases in which poison was taken by mouth within one or two days.
Blood	At least 10cc (preferably 200cc)	All gas poisons, methemoglobin, sulfonamides, bromides, drowning test, and many other poisons.
Brain	500 grams	Volatile poisons, barbiturates, alkaloids, and acute alcoholism, etc.
Liver	300 grams	Metals, barbiturates, fluorides, oxalate, sulfonal, and many other poisons.
Kidney	One kidney	Metals, especially mercury, sulfonamides.
Bone	200 grams	Lend, arsenic, radium (especially chronic).
Lung	One lung	For inhaled poisons (proof of entry).
Hair, Finger & Toe Nails	5 grams	Chronic arsenic poisoning.
Muscle	200 grams	In most acute poisoning, and when internal organs are badly putrefied.

It is most satisfactory if the specimens are delivered shortly after first being obtained. The autopsy should be performed before the embalming of the body since formaldehyde interferes with tests for cyanides, methyl alcohol, phenols, carbon monoxide, and alkaloids, and hardens the tissue to such an extent that other analyses are difficult. When a chemical preservative must be used, 95 per cent ethyl alcohol is to be preferred except, of course, where a determination for ethyl alcohol is indicated. In all cases, a sample of the preservative used should be submitted so that it can be analyzed for foreign substances.

Where accident or suicide by poison has been a matter of legal dispute, the records show that in many cases no effort has been made to show that poison was the actual cause of death!

### Leads and Clues

FROM the standpoint of the toxicologist it is indispensable that he have certain preliminary information for several reasons:

1. Attention can be concentrated on certain groups of poisons,

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Like its larger prototypes, the Firsturn Electrostatic Generator consists, essentially, of an endless, charge-conveying belt, which, as the crank is turned, moves into and out of a hollow metal terminal. Thus is the Van de Graaff principle reduced to its simplest, most comprehensible terms.

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Although the Firsturn Generator is primarily designed for hand operation, the drive wheel is grooved, to serve as a pulley when a motor drive is desired.

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Principal dimensions are as follows: Height, overall, 21-3/4 in. Width of terminal, 16 in. Width of belt, 5 in. Size of base, 6 x 13-1/2 in. Diameter of discharge ball, 3-1/2 in.



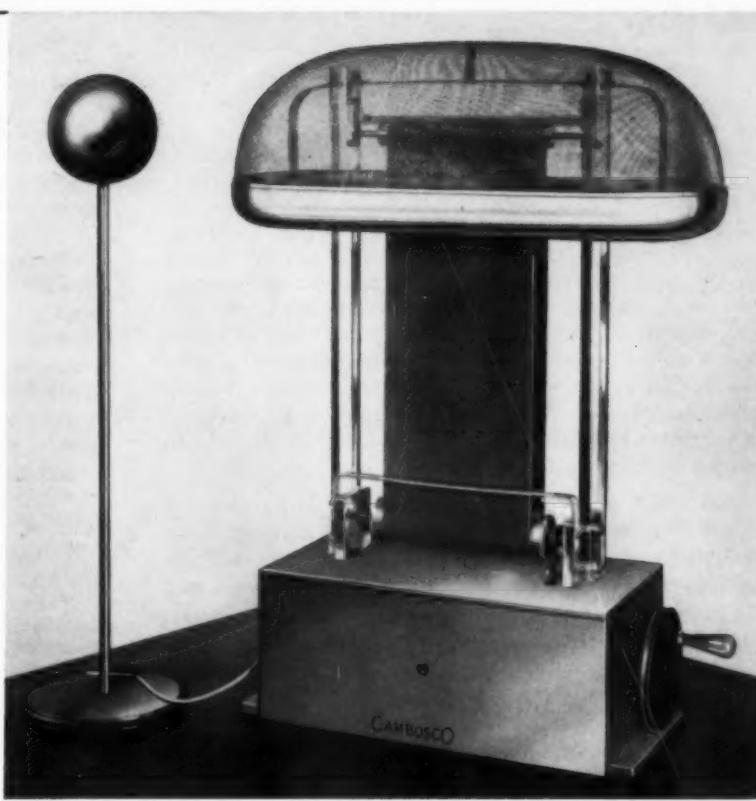
## NOTES

• So named because a spark is produced at the first turn of the crank.

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▲ A conservative rating, based on many trials under average operating conditions. Under ideal conditions, a potential difference of 300,000 volts has been achieved.

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*At the first turn of the crank, this modern Electrostatic Generator emits a crashing spark, whether the day is dry or humid! For that reason alone, it will be welcomed by every physics teacher who has ever apologized for the temperamental performance of an old fashioned "static machine."*

**NO FRAGILE PARTS.** The Firsturn Generator is constructed entirely of aluminum, brass, plexiglass, rubber, steel and wood. There are no Leyden jars; in fact, no condensers of any kind. There are no plates to warp or break; no shunts, brushes or collectors to adjust; no segments or button disks to re-stick!

**NO "TRANSFER BODIES."** In conventional influence machines, whether of Holtz or of Wimshurst type, charges are collected and conveyed (from rotating plates to electrodes) by a system of "transfer bodies." Such bodies include: brushes, rods, button-disks, and foil or metal segments, each of which, inevitably, permits leakage of the very charge it is designed to carry, and thereby sharply limits the maximum voltage. In the Firsturn Generator (but in no other self-exciting electrostatic machine) electrical charges are established *directly* upon the discharge terminal.

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2. Large numbers of time-consuming analyses can be avoided, and
3. Limited material can be more efficiently utilized. A lead and clues can be obtained from:
  - a. Circumstances surrounding the death or illness,
  - b. Symptoms and behavior before death, and
  - c. Gross and microscopic autopsy findings.

It is essential to know the first appearance of symptoms of death after taking last food or drink, the nature and intensity of these symptoms, whether or not there was vomiting, deep sleep, tingling of skin and throat, convulsions or twitching of the muscles, delirium, dyspnea, contraction or dilatation of pupils, changes in vision or hearing, etc., in addition to any evidence found at the scene. The autopsy findings aid in eliminating or considering certain poisons with selective effects on the various tissues.

The symptoms and behavior of the patient may be of great help in excluding or taking into account large groups of poisons which probably would or would not be present. Following is a partial list of symptoms and signs produced by various poisons.

**Vomiting:** Heavy metal salts; corrosive acids and alkalies; halogens; aconite; cantharides; croton oil; gelsemium; phosphorus; phenols; wood alcohol; veratrum; muscarine.

**Convulsions:** Ammonium salts; aspidium; brucine; camphor; saponin; aconitine; picrotoxin; cyanides; strychnine.

**Coma:** Opium; morphine; heroin; barbiturates; chloral hydrate; sulfonal; trional; paraldehyde; chloroform; ether; cyanide; carbon monoxide; carbon dioxide; atropine; nicotine; hyoscine; alcohols; phenols; scopolamine.

**General or Partial Paralysis:** Cyanide; carbon monoxide; carbon dioxide; botulism.

**Dilation of Pupil:** Belladonna and derivatives; hyosciamine; stramonium; alcohol; gelsemium; cocaine; nicotine.

**Contraction of Pupil:** Opium and derivatives; physostigmine; pilocarpine; muscarine.

**Slow Respiration:** Opium and derivatives; carbon monoxide; hypnotics.

**Rapid Respiration:** Belladonna and derivatives; cocaine; carbon monoxide.

**Delirium:** Belladonna and derivatives; cocaine; alcohols; camphor; solanine; marihuana.

**Dyspnea:** Strychnine (during convulsions); cyanide; carbon monoxide; carbon dioxide; easily volatile organic liquids.

**Cyanosis:** Nitrobenzene, aniline; acetanilid; opium; chlorates; amyl nitrate.

**Staining of the Skin:** Iodine, black; bromine, deep brown; nitric acid and picric acid, yellow; phenol, bleaching.

**Abnormal Coloring of the Urine:** Phenol, salol, resorcinol, dark green; antipyrine, trional (after long use), red; pyrogallol, brown or black; picric acid, yellow; santonin, bright yellow changing to scarlet on adding caustic alkali.

**Abnormal Coloring of the Skin or Mucous Membranes:** Carbon monoxide, nitrates, cyanide, cherry red or pink; silver salts, black blotches.

**Discoloration of Gums:** Lead, mercury, bismuth (usually chronic poisoning).

**Abnormal Odor of Tissues at Autopsy:** Phenol; creosote; chloroform; cyanide; ether; alcohol; nitrobenzene; phosphorus; crude opium. •

#### GLOSSARY

**Toxicology** is the science of poisons. It deals with:

1. Origin of poisons
2. Properties
3. Symptoms
4. Lethal doses
5. Antidotes
6. Analyses (isolation, detection and quantitative determination)
7. Evaluation and interpretation of results.

**Poison** is any substance which will cause ill health, disease or death when introduced into the body in sufficient amounts.



"Although we are still surrounded by the vestiges and remnants of a formerly more militant pragmatism, I believe that we have successfully confined the overt forms of progressive education to the limbo of unredeemed ideas. Soft pedagogy, as far as I am concerned, means a soft, fat, sated mediocrity; hard pedagogy, on the other hand, if its sternness merely gives lip service to honest discipline, means nothing; what we seek is a reasoned and reasonable discipline that will help a man to be tolerant of the shortcomings of others while he becomes highly intolerant of his own."

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## Syracuse University

(Continued from Page 8)

Other things being equal, it was felt that the best teaching would be done by those people who have the ability to contribute to the knowledge which they expound. Accordingly, the programs in the natural sciences and the humanities, which lead to a Ph.D. degree, call for a research thesis of the qualities usually expected of Ph.D. candidates. The thesis, however, may be of two kinds: (a) it may be a scientific subject matter thesis. It is hoped, however, that research problems will be developed which cross the borderlines of disciplines. Thesis work in collaborative projects between different departments, for instance in Plant Science and Physics, will be encouraged. In this way, it is visualized, greater breadth and usefulness may come of the research experience. The second type of thesis authorized is that concerned with problems in the methods of teaching science. Actually, in practice, none of these have yet been approved. Problems in this field will be available when the vacant professorship in Science Education is filled.

These programs were not designed as easy routes for the title of "doctor" for second-rate students. If their requirements are faithfully met, they will if anything be more exacting than the departmental degree programs. The programs are recognized as experimental. Details are being adjusted as best they can be for each individual student and must necessarily vary greatly depending upon his background and probable

needs. Other universities are tackling the same problem each in its own way. There will likely emerge from these experiments eventually a more standardized pattern. The Syracuse faculty committee which devised the new programs did not grant the validity of some of the wholesale assaults that have been made on traditional graduate training methods by certain educational spokesmen. The past was not so bad that we have to throw away its accumulated traditions and experience. We grant the need, however, to be ever-vigilant in seeking ways of adapting past procedures and present resources to new needs and new problems. Our experiments represent a step in that direction. ●



## The Photoflash Lamp

(Continued from Page 14)

the spot is sufficiently moisture sensitive to be turned pink by the moisture in the air.

Aside from the improvement of the existing techniques for the manufacture of photoflash lamps and the development of light sources of a completely different nature, two important problems of photoflash development are the reduction in size of the bulb for a given light output and the development of a successful transparent plastic jacket to replace the glass bulb. Either of these is of sufficient importance to be rewarding to the individual who can bring the development to a commercially practical conclusion. ●

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## How Many Mesons?

(Continued from Page 4)

tron volts times 34 feet, the height of the water barometer, or  $2.38 \times 10^9$  electron volts. Now mesons have also been detected far below sea level—distances comparable to a mile of water. Such mesons would lose, in addition, energy of 5,280 times  $7 \times 10^7$  electron volts, or approximately  $3.7 \times 10^{11}$  electron volts.

The facts concerning the  $\mu$ -meson were not as well established in 1947 as they are today. A considerable amount of investigation had been carried on, and each new observation seemingly added to the difficulty of correlating facts with theory. To such an extent was this true that several articles appeared in defense of Yukawa's nuclear theory, stating that Yukawa wrote his theory independently of the meson, and that such a particle in nuclear forces was the Yukawa particle and it was not to be confused with the meson in cosmic rays. This apparent difficulty was settled at least in part, by the discovery of the positive and negative character of the meson, and also by the discovery of a heavier meson at higher altitudes.

Such mesons are officially known as  $\pi$ -mesons, and are also recognized as heavy mesons,  $\sigma$ -mesons, and transverse mesons. The mass of the  $\pi$ -meson is 285 times the mass of the electron. It carries the same charge as the electron, either positive or negative. This particle is capable of undergoing decay or nuclear capture. In the case of the former, the  $\pi$ -meson decays into a  $\mu$ -meson and a neutrino. The process of nuclear capture also varies somewhat from a similar process observed in the case of the  $\mu$ -meson.  $\mu$ -Mesons are captured only by nuclei of large atomic number while  $\pi$ -mesons are captured by either heavy or light nuclei. The latter reaction results in a nuclear disruption which is characterized by a so-called "star" produced on the photographic plate. Instead of emitting a neutrino as in the case of the  $\mu$ -meson, the  $\pi$ -meson transfers its energy into kinetic energy of the nucleons with which it collides, and the result is a nuclear disruption. Still another point of contrast between these mesons is that the high altitude  $\pi$ -mesons are strongly coupled to nucleons whereas the sea level mesons, as decay products of the  $\pi$ -mesons, are only weakly coupled to nucleons.

In an endeavor to study a relationship between frequency of occurrence of  $\pi$ -mesons with increasing altitude, the third and most recently discovered meson was observed. This is called the  $\tau$ -meson. Such a meson has a mass of approximately 800 to 1000 times the mass of the electron. It was observed at altitudes of 90,000 to 100,000 feet above sea level. Photographs indicate that such a meson decays into three lighter particles, one of which is the  $\pi^-$ -meson and the other two are possibly  $\pi^+$ -mesons.

Early studies of cosmic rays estimated a minimum energy of 1000 million electron volts to discharge a meson from the nucleus. With the advent of the cyclotron such a process proved possible. Consequently

mesons are now being studied as intensively in the laboratory as they are in nature.

With the use of the 184" cyclotron in the Berkeley laboratory, mesons are produced by bombarding various targets with 380 million electron volt alphas and protons. The projectiles are directed against a  $1/16$ " target and the released mesons are passed through a magnetic field and directed into two stacks of photographic plates so placed as to be in the path of the oppositely charged particles. It is interesting to observe that in the use of the carbon target the ratio of positive to negative mesons is 1 to 5. With other targets of approximately  $1/64$ " thickness and of varying materials this ratio approaches zero with an increase in the atomic weight of the substances.

The observation of only  $\pi$ -mesons being produced in such bombardments leads to the conclusion that  $\pi$ -mesons constitute the medium of nuclear force, and not the  $\mu$ -meson. Any  $\mu$ -mesons which are observed are the result of the decay of the  $\pi$ -meson. The  $\tau$ -meson has not as yet been observed in any artificial production of mesons.

It is evident from the extensive research already done that the study of the meson is not complete. Will further investigation reduce the number of mesons to "shall we say, one?" •



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## Modern Bread Making

(Continued from Page 24)

thawed, such bread is not only soft but has good flavor. Recently it has been demonstrated that certain surface-active compounds when added to bread, retard the firming of the crumb. However, most of these materials have been omitted from the proposed Standards of Identity for Bread.

### Microbiology of Bread

The baking industry is vitally concerned with the role different microorganisms play in the manufacture of bread. This concern takes into account both the suitable and unsuitable types of microorganisms. One, yeast, is needed to ferment doughs for the production of bread and yeast-raised sweet goods. Other microorganisms which produce lactic or acetic acid are used in the production of sour type breads, such as sour rye. These microorganisms are beneficial and accomplish the ends desired by the baker. However, there are other microorganisms such as molds, wild yeasts, and certain slime forming bacteria that are harmful to baked products. Science has accumulated a background of knowledge about these various microorganisms and has shown the baker how to improve the effect of those that are beneficial and how to control the others.

**Mold**—Bakers have always been troubled with bread molding, but the problem was aggravated when the baking industry adopted the sanitary waxed paper or cellophane wrapper, and again when bread was first sliced at the bakery. The sanitary wrapper is an efficient barrier to the passage of moisture vapor and tends to keep the wrapped loaf surrounded by a humid atmosphere. This, combined with an elevated temperature, will promote the growth of any mold spores that may have infected the bread. Molds of the *Aspergillus*, *Rhizopus*, *Penicillium*, *Mucor*, and *Neurospora* genera are commonly found on baked products.

Although various baking ingredients may contain mold spores, they are not responsible for visible mold on bread because mold spores in the dough are destroyed during baking. When bread does mold it has been caused by air-borne spores that have come in contact with the bread during cooling, slicing or wrapping, later germinating and growing to visible colony size. Investigation into the growth of mold on baked products indicated that mold growth is inhibited by the addition of acetic acid (vinegar) to the dough. In time, this led to the investigation of the mold inhibiting properties of fatty acids with a greater number of carbon atoms than acetic acid. It was found that fatty acids containing eight to twelve carbon atoms are most effective as mold inhibitors, but that their use is impracticable because of the objectionable flavors they impart to baked products. Propionic acid, containing three carbon atoms, was found to be an effective, unobjectionable mold inhibitor. The effectiveness of propionic acid is not dependent on the lowering of pH alone, but also on the undissociated part of the fatty acid molecule. Propionic acid occurs naturally in dairy

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foods, and the use of small amounts in baked products has been shown to be harmless. The proposed "Standards of Identity for Bread" permit the use of calcium and sodium salts of propionic acid in bread.

**Rope**—Until approximately twenty-five years ago bakers dreaded that a condition known as "rope" might appear in the baked products they made and sold. A "ropy" condition is characterized by the baked product acquiring an unpleasant, ethereal odor similar to that of overripe melon; later the crumb becomes discolored and partially liquifies so that it may be drawn out in tenuous threads.

Pasteur first discovered that a "ropy" condition in wine and beer was caused by microorganisms of the *Bacillus mesentericus*<sup>2</sup> group. Laurent, in 1885, found similar organisms in "ropy" bread, in various grains, flour, and soil. He observed that the spores of *Bacillus mesentericus* were not destroyed during baking and that bread containing a certain amount of acetic acid, did not become "ropy." Later investigators confirmed these observations. It was also found that spores of different strains of the rope organism could survive the temperature of boiling water for as long as six hours.

Unlike mold spores which are destroyed during baking, "ropy" spores resist baking temperatures and may cause "ropy" bread because the interior temperature of bread during baking does not go above that of boiling water. Such temperatures actually induce germination of the spores, and after baking, the spores become vegetative cells which utilize the bread for growth purposes and produce the "ropy" disease in the product. The necessary conditions are source of food, high temperature, and adequate moisture. In addition, the microscopic spores of rope organisms may be airborne and thus infect baked bread.

As bakery sanitation has improved and suppliers of various baking ingredients have held rope spore counts to a minimum or eliminated them from their products, "ropy" bread has virtually disappeared. Rope can be controlled by lowering the pH of the dough by the addition of vinegar, calcium acid phosphate, or lactic acid. Calcium and sodium propionates aid by inhibiting mold growth.

The advances in baking technology outlined in this article highlight progress that has been made and is continuing in this field. At present, in Federal, State, and industrial laboratories fundamental research related to many of the problems of the baking industry, is being conducted. New products and ideas, for example, the bulk handling of flour, sugar, and other dry ingredients; silicone resin-coated baking pans that eliminate pan greasing; continuous dough mixing machines; and the use of radio-frequency heat have been introduced to and are being tested by the baking industry. Because they know the value of research and applied scientific knowledge, many members of the baking industry today maintain laboratories where new or improved formulas, processes and ingredients are developed. ●

<sup>2</sup> Bergey, *Determinative Bacteriology*, 6th Ed., Williams and Wilkins Co., Baltimore, 1948, designates American strains of *B. Mesentericus* as *B. pumilus* and European strains of *B. mesentericus* as *B. subtilis*.

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## Lyophilized Blood Plasma

(Continued from Page 19)

Human Plasma, a liquid lifesaver dehydrated for distribution.

Clinical studies by the Division of Medical Sciences of the National Research Council reveal that "Lyovac" plasma is the blood product best equipped to meet the emergency demands of our present civilization. It requires no special storage facilities, it is non-perishable, it requires a minimum of shipping space and it may be administered to all victims regardless of blood type.

As a result of World War II medical studies it was found that some patients developed serum hepatitis (serum jaundice) following injection of pooled plasma. Despite careful selection of blood donors under strict supervision, there was still the possibility that some blood would contain the hepatitis virus, since no laboratory tests exist for its detection. However, in 1948, Sharp & Dohme developed a method of irradiating plasma with ultraviolet radiant energy since this process had been shown to destroy many laboratory viruses.

Using Sharp & Dohme equipment, plasma known to contain the hepatitis virus was irradiated and tested with human volunteers by clinical scientists at the University of Pennsylvania. The volunteers who used the irradiated plasma did not develop the disease while about half of the volunteers using unirradiated plasma did. It was, therefore, concluded that the irradiation process had rendered the plasma non-infectious.

Processed by the lyophile technique which involves irradiation, rapid freezing, and dehydration under vacuum, the dried plasma retains all of its original healing qualities.

Conversion of blood plasma to the frozen state is accomplished by rotating the container in a special low-temperature bath far below the freezing point of water. This "shelling" process, as it is called, causes the plasma to form a layer on the inside wall of the container, thus exposing a large surface of frozen material and facilitating the removal of water.

The frozen plasma is subjected to a high vacuum to remove the water vapor without melting or softening the material itself. Since tests show that dried plasma is best preserved in a vacuum, the lifesaving agent is sealed in a completely air-free container.

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## Saint Patrick's Shamrock

(Continued from Page 3)

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## Nickel in the Modern World

(Continued from Page 12)

alloys. Such uses have been greatly expanded by the use of clad-steels, which consist of a relatively thin layer of the resistant metal or alloy permanently bonded to a less expensive steel plate. The pleasing appearance of polished surfaces of these metals, which signifies resistance to atmospheric corrosion, also gives them many architectural and related uses.

Special steels and other alloys containing higher percentages of nickel and chromium provide a high degree of resistance to scaling and comparatively high strength at elevated temperatures, upwards of 1000°C. For this reason they are extensively used for furnace parts, mechanical stokers, diesel engine valves and for related applications where corrosion resistance and strength at high temperatures are essential. Jet aircraft engines rely for many of their parts on alloys composed chiefly of nickel and chromium to withstand the combined attack of high stresses, high temperatures and aggressive exhaust gases. In addition, certain other alloys containing nickel and chromium have the useful

property of high electrical resistance, which causes them to be used for industrial furnace windings, domestic heating appliances, electric flat irons and so on.

The magnetic and electrical properties of nickel and its alloys, particularly alloys of the nickel-iron series, play an important role in the successful operation of radio, television, telephone, radar and other communication systems. Ever since the early tests of Dr. Lee De Forest, nickel has been the standard metal for certain parts of vacuum tubes, such as the cathode, grid, plate and plate supports. In addition to these, many other small but vital parts of communication systems, television receivers, control assemblies, precision instruments, measuring devices, motors, and generators call for the special magnetic, thermal expansion, elastic and electrical properties that are provided by nickel and its alloys. Powerful permanent magnets of many kinds are widely used; it is reported that more than 300 of them are used in a large military airplane.

By varying the composition of certain nickel-iron alloys, a surprisingly wide variation in the rate of thermal expansion can be produced. For example, with about 20 per cent of nickel the expansion rate is high, but it becomes progressively lower as the nickel is increased, until in the region of 36 per cent a nickel-iron alloy (Invar) is obtained with practically no thermal expansion at all. Additions of nickel beyond this range increase the expansion rate once more. With such a wide and predictable range of expansion rates, it is clear why the nickel-irons are used in instruments of many kinds to compensate for the expansion or contraction of other metals with changing temperature.

The addition of nickel to many types of cast iron also gives increased strength, hardness and corrosion resistance to this well-known material.

There are reported to be more than 3000 different alloys containing nickel in active use, specifically chosen for their special physical and chemical properties, so it is clear why we cannot mention more than a few of the most outstanding alloys in this brief survey.

The use of finely-divided nickel as a catalyst should be mentioned, especially in the hydrogenation of unsaturated fats. It has now become standard practice in many lands to "harden" liquid oils derived from cotton-seed, linseed, soy beans, marine life, and so on, in the presence of a nickel catalyst. This step helps to preserve such unsaturated fats, and makes them acceptable for many new purposes at moderate cost. The direct effect of this is to increase the food, soap and cosmetic supplies of the world and to provide an incentive for oil-producing tropical countries to reap an economic benefit from their copious sunshine.

The account of nickel so briefly presented here is far from an adequate story of the manifold uses of nickel in the modern world, but perhaps enough has been said to confirm Cronstedt's modest contention of 200 years ago, that he had discovered a new material with many unusual properties which he hoped would prove useful. •

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